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COMPOSTING OF ORGANIC WASTES. AN ANNOTATED BIBLIOGRAPHY, SUPPLEMENT 2

John S. Wiley

Communicable Disease Center
Atlanta, Georgia

April 1960

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SUPPLEMENT 2

COMPOSTING OF ORGANIC WASTES--AN ANNOTATED BIBLIOGRAPHY

John S. Wiley, Editor
Biophysics Section

Introduction

This third bibliography on composting supplements the initial one, published in February 1958 (abs. 1-145), and the first supplement, published in June 1959 (abs. 146-287). As before, numerous articles on this subject have appeared in the short interval since the last issue, largely foreign, for there is still more activity in both research and in plant installations in Europe than in America.

The International Research Group on Refuse Disposal (IRGR) continued to grow, held its first International Congress on Disposal and Utilization of Town Refuse at Scheveningen, April 27-May 1, 1959, and has issued a total of seven Bulletins of Information. The PHS Communicable Disease Center has distributed the English versions of these bulletins and, again, articles appearing therein are not repeated here, but are listed alphabetically by senior author with the notation "see IRGR" (211, 328). The IRGR bulletins and the preceding annotated bibliographies may be obtained from PHS, CDC, TDL, P. O. Box 769, Savannah, Georgia.

Composting is rapidly increasing abroad with about 32 Dano biostabilizer plants built or under construction (375), 12 rasping system (with windrow composting) plants (343), and a number of enclosed plants employing mechanical intermittent disturbance. The van Maanen system, however, appears to be on the way out (368) and many of the Earp-Thomas plants have been discontinued (309, 333). The Jersey system (323) appears to be well-received inasmuch as a large plant of that type is completed at Bangkok (300). Other large plants reportedly under construction are at Tel Aviv, Israel (372), Brussels, Belgium (375), Arnhem, the Netherlands (343), and Stuttgart, Germany (343). It has also been reported that Cairo, Egypt (300), Vienna, Austria (300), and Budapest, Hungary (300,386) are composting. Some unique plants are those at Calais, France (307), Mabelreign, Southern Rhodesia (334), Uzwil, Switzerland (310), the dump reclamation plants at Tel Aviv (372), and the refuse-night soil plants at Dantumadeel, the Netherlands (281) and Blaubeuren, Germany (343). Emphasis in Europe is now being placed on the joint treatment of refuse and sewage sludge or night soil (297, 329).

There has been little change in the composting picture in the United States. The 40 T/day plant of the Naturizer Company at Norman, Oklahoma, is in operation and the small Williamston, Michigan, plant has been taken over by the city (376), the only municipally operated plant in our knowledge treating garbage or refuse. The Dano plant in Sacramento County, California, plans an expansion (370). With the advent of the sludge dewatering centrifuge (326, 329, 382) and vibrating sieve (327, 329, 337, 374), and their low operational costs, it appears that refuse-sludge

composting should "catch on" in the United States. There is no change in compost utilization, although in addition to agronomic uses it would appear that the deep litter method of poultry raising (276, 336) might provide an additional limited market.

Errata in Supplement 1, Annotated Bibliography

	Page	Abstract
"Kirkonnel" should be "Kirkconnel"	8	154
ditto	25	200
"Vemura" should be "Uemura"	21	---
"1952" should be "1954"	27	203
"formers" should be "farmers"	28	203
"44 m" should be "4.4 m"	38	227
"Becarri" should be "Beccari"	61	---

Bibliography on Composting of Organic Wastes
Supplement 2

288. Anon.- Interim report of joint working party on municipal composting, 1959. Joint Working Party on Municipal Composting (Br.), Bull. 20pp, Feb. 1959.

Composting of household refuse, after removal of bottles, tins, etc, is accomplished in time by the action of bacteria and fungi. The shredding of refuse insures a more uniformly-matured material suitable for application to the soil. Recently composting has included various mixtures of animal and vegetable wastes, animal bedding mixed with urine and dung, and habitation wastes including night soil or sewage sludge. In aerobic action the molds and thermophilic bacteria multiply, fixing nitrogen and producing temperatures that kill pathogens and prevent fly breeding. In anaerobic action little temperature change occurs, pathogens and parasite eggs tend to survive unduly long, nitrogen is lost, unpleasant odors tend to be emitted, flies breed, and nuisance is caused. This bulletin deals with the aerobic compost production from domestic refuse, sewage sludge, and other urban refuse.

The Joint Working Party was formed by the Soil Association, the Inst. of Public Cleansing, and the Inst. of Sewage Purification, and includes representation from the Assoc. of Public Health Inspectors and an observer from the Society of Medical Officers of Health.

Definitions are given for sewage and household refuse with constituents, after sorting of the refuse: over 2% N in sludge, about 0.9% N in refuse; 1-1/2% phosphate in sludge, 0.6% in refuse; and 0.3-0.4% potash in each. Sludge presents a disposal problem as the liquid raw sludge is not entirely suitable for use in agriculture. Domestic refuse, amounting to about 15 cwt./1,000 pop./day, is generally disposed of in Britain by incineration and controlled tipping, the latter predominating. Incineration is expensive in both capital and operating costs and still leaves a residual material to be disposed of. Air pollution is also a factor. Controlled tipping is cheaper and provides for land reclamation but availability of suitable sites close to population centers is diminishing. Many authorities are involved with transportation of refuse up to as much as 40 miles.

The soil: (1) supplies plant food, (2) supplies structure conducive to root growth, (3) retains moisture, (4) houses microorganisms and other creatures upon which plants appear to depend, and (5) permits circulation of oxygen needed by the soil population. Basic nutrients are C, N, K, and P and there are also important trace elements. Fertile soil has binding agents to hold water and prevent erosion, and provides humus which furnishes habitat and nutriment for soil organisms. Failure to maintain the humus in soil will in the long run cause soil

288. deterioration, diminished microorganism population, destruction of crumb structure, and erosion. "If the soil is to be the inexhaustible store of nourishment which human cultivation demands, chemicals alone cannot provide the essential replenishment required for the support of animal and human life." "...as both materials (sewage sludge and domestic refuse) are produced during the normal exercise of their public health functions by local authorities, the opportunity arises of composting them together and so transforming waste matter into a substance of value to our national life."

Adoption of composting by a city will be most attractive when existing methods of treatment of sewage and refuse are inadequate or uneconomic. Composting can be undertaken on any scale that is found convenient. It is mainly an engineering matter directed at handling materials in such a manner as to maintain fundamental conditions required by the composting organisms. Principal steps are: (1) sorting for salvage and discard, (2) aeration of the sludge-refuse mixture, (3) maintenance of adequate moisture content, (4) temperature control to a range of 130-150°F, (5) proper proportioning of raw materials, preferably to a C:N of 30:1 initially, and composting to a C:N of 20:1, and (6) grinding or shredding to reduce particle size. The separation process should include removal of glass, either before or after composting, to eliminate the danger from splinters.

The Indore system and the more recent modification at Kirkconnel are described. Composting is in cells with natural ventilation with the process requiring a relatively long time and large area. The Jersey system composts in a 6-story tower in cells for one day each, followed by maturing and storage of the compost. The Dano process accomplishes the basic decomposition in about a week in a slowly rotating drum to which air is supplied. The first Edinburgh Dano plant is described which was so satisfactory that 3 more Dano biostabilizers have been installed in that city to replace incineration. The need for inocula is not apparent.

The local authority can sell either in bulk to wholesalers or direct to large farms, or retail in small quantities. The price of compost will depend on the value the users attach to it. The whole output in Edinburgh has been sold to a contractor. Composting need not make money and, if it costs no more than other methods of disposal, "it is sufficiently justified apart from any incidental benefits it may have to national life."

As for location of the composting plant, it costs only 0.36¢/wet ton-mile to pump sludge a distance of 7 miles while refuse hauling costs 8.4 to 18.2¢/ton-mile. Other factors for site location are availability of land where no sound complaints from nuisance can arise and length of haul of the refuse collection vehicles from the area to be served. In larger cities it may be advisable to provide several composting plants to reduce haul distances, unless several transfer depots are envisioned.

288. Appendix A lists 13 references; Appendix B gives trace element contents of the compost from Edinburgh, Dumfries (Kirkconnel), and Jersey.

289. Anon.- Our guardian angel. Pub. Cleansing 49 (586) 340-1, June 1959.

The Manchester Guardian undertook to set forth its views on the composting issue. It observed that domestic and market gardeners are finding it increasingly difficult and expensive to return to the soil the humus consumed by intensive cultivation. Also it concludes that the local authorities could save the taxpayers a great deal of money by converting sewage and refuse into a rich source of humus, if only the Minister of Housing and Local Government would "sanction the investment of loan capital in the necessary plant".

The Guardian considers the Minister's attitude to be deplorable but it may be explained in part by the "mystic attitude which still surrounds the composting question" and in part because household waste "falls between departmental stools", i.e. the Ministries of Housing and of Health. The Ministry of Agriculture wants to maintain farm fertility but the newspaper claims this can be done cheaply "by taking the plough round the farm".

The 1954 Zuckerman Committee report concluded there was "no case for authorizing public expenditure on pilot composting plants because of the uneconomic nature of the process". This is now held as little more than pretext. Whereas the Committee estimated composting cost at $8.40/long ton, the Guardian now finds it to be only $1.40/T for a 100T/day refuse plant handling sewage sludge also. Cost is $2.94/T for compost produced. Compost prices vary from $3.50/T ex works for the rough, immature product of Leatherhead's pre-war pits to $11.20/T for the better quality supplied at Kirkconnel, Dumfriesshire. While these prices may come down when compost is in more generous supply, there should be no difficulty in disposing of all the compost to horticulturists at $2.94/T, making composting preferable to controlled tipping, the latter costing a minimum of $0.42/T. Even at $1.40/T for compost, composting would be financially sound.

290. Anon.- All in one fell swoop. Pub. Cleansing 49 (586) 354, June 1959 (see also: Refuse Removal Jour. Mar. 1958).

J.F.T. Berliner, Chicago Consulting Engineer, together with the Williams Patent Crusher and Pulverizer Co. of St. Louis and E. W. Hebestreet, Municipal Disposal Systems, Inc. of Chicago, have developed a composting system for municipal refuse. Steps are: receiving hopper with conveyor bottom, picking belt, magnetic pulley separation, grinding to -4 in., secondary magnetic separation, secondary grinding with mixing of sewage waste and carbon black, composting in 10 bins with continuous conveyance in series, and screening.

290. Grinders are of the Williams hammermill type, the secondary one reducing to 1/2-3/4 in. The sewage provides necessary moisture and is measured. The carbon black adds "a special value not found in any other substance intended for the enrichment of agricultural soil". The finished compost is sold in bag or bulk under the name "Orbon" by the Orbon Corp.

291. Anon.- Official opening of the Mabelreign mechanical composting plant recently erected by the Composting Company of Rhodesia (Pvt.) Ltd. for the Mabelreign Town Management Board by Mr. Gordon Deedes. mimeo. 2pp, undated (transmitted July 2, 1959).

An introductory paragraph describes the need for composting. The plant consists of: inclined tipping platform, picking belt, magnetic separator, tins baler, paper baler, conveyor, 2 fermenting "silos" with air ducts and a "turner aerator". The "silos" are 100 ft long x 7 ft wide x 5 ft 9 in. high. Forced air is supplied to air ducts beneath them. The "turner aerator" is a machine which travels within the silos daily or every other day, "disintegrating", moving, and aerating the refuse. The refuse is progressively composted as it is moved along the silos to the delivery end, where it can be automatically loaded into a waiting truck. Compost can be used agriculturally immediately or for gardens after stockpiling for one month.

The plant is designed to receive 6-10 T/day of mixed refuse. Estimated compostables are 80% of the refuse. Water, sewage, or sewage sludge can be used as the wetting agent. Operations began on Jan. 16, 1959. Compost analysis (DW) is: total N - 1.4%; P_2O_5 - 0.7%; K_2O - 1.1%; ash - 41.8%; C/N - 19.7. Compost moisture content is 40-65%. Grinding and bagging have not yet been provided. It is expected that salvage and compost should return $8.75/T of refuse but as a conservative estimate a figure of $5.60/T is being used. (See also Keeble, abs. 334).

292. Anon.- The time to compost. Pub. Cleansing 49 (588) 557, Sept. 1959

As indicated by the report of the Joint Working Party (on Municipal Composting), a local authority should consider composting of refuse and sludge before embarking upon a refuse or sewage treatment plan. The composting method would be most attractive when existing methods of waste disposal of the community are in whole or in part obsolescent. Composting solves two problems with one scheme. However, it is not necessary to await these ideal conditions before considering composting. Assessing the probable life of the sludge- or refuse-treatment plants might show that composting would be more economical in the long run. "In many instances composting may provide the most economical solution from the point of view of the local authority and certainly the most beneficial solution from the point of view of the national agronomy."

Anon.- (See also News item, Editorial)

Anon.- Progress in Israel. Pub. Cleansing 49 (586) 333-5, June 1959.

(Ed. note: This presents the same data in shorter form as the paper by Shuval, see abs. 372).

293. Blair, M. R.- The public health importance of compost production in the Cape. Public Health (Johannesburg) 15: 29-37, Feb. 1951.

Many towns of the Cape Province compost domestic and other wastes. This paper covers procedures, problems, successes, and deductions, emphasizing the public health and nutritional aspects.

The S. A. soil needs compost to supply nutrients and stop erosion. The author indicates that "improved fertility of the soil will result in improved quality as well as quantity of foodstuffs produced for man and beast, and will thus promote better nutrition". Local authorities have a responsibility for wastes "utilizing these wastes, converting them into fertiliser, and finally for educating the public to their value".

"The correct manufacture of compost actually destroys the organisms responsible for the spread of bowel diseases such as typhoid, cholera, infective dysenteries and worm infestations". The Union Health Dept. concurs, when the composting is conducted in accordance with the pamphlet issued by the Dept. of Agriculture.

In the author's survey he found that 11 of 28 cities and towns had discontinued composting operations. Of the 17 continuing, 14 were "in complete favour" and 3 were "in favour but with reservations" to composting as a satisfactory solution to the problem of nightsoil and refuse disposal.

The composting is done in pits with hand labor for mixing the wastes and turning the composting matter. This method permits fly breeding unless adequate temperatures and turning schedules are maintained. A period of 60 days with 3 turnings is recommended, after which the compost is "put out to dry and sifted".

Raw materials varied and included sieved household refuse (14 authorities), chaff or straw (10), animal manure (2), sawdust (2), garden refuse (5), abattoir wastes (2), and nightsoil (all). Ratios of nightsoil to refuse varied from 11:1 to 0.74:1 at 14 places (in gal. of nightsoil:cu ft of refuse). Costs for construction of the pits (recommended size is 2 ft deep x 8 ft wide) varied from $95.20 to $473.20/1,000 cu ft or sufficient pit volume to serve about 500 people. Production costs varied from a profit of $364 to a loss of $3,920/yr, with 2 authorities showing a profit and 13 showing a loss. Compost sells at an average price of $0.36/bag (size not given).

293. Only one of 13 authorities showed composting net costs to exceed the "usual costs of disposal of nightsoil and refuse" and the average net gain by composting was $1,450/yr.

The author concludes that composting of refuse and nightsoil is economical (by the pit method for pop. of 500-25,000), that the operation requires meticulous supervision (especially to avoid fly breeding), that the compost is a "rich source of agricultural fertiliser for improving South African agriculture and human nutrition", and that there is "scope for an enormous increase in the manufacture of compost in this region".

294. Bloodgood, Don E.- The composition of refuse. APWA Yearbook, 100-11, Nov. 1959 (also summarized in: Pub. Wks. 90 (11) 125, Nov. 1959).

Data from various cities throughout the world indicate that refuse density has decreased from over 40 to as little as 6.0 lb/cu ft since the beginning of the century. Similarly densities of various constituents of refuse averaged: garbage - 37.0; paper - 6.3; metal - 7.6; glass - 24.1; and ashes - 39.3 lb/cu ft. The Purdue studies were made of refuse from W. Lafayette, Ind., Baton Rouge, La., and Chicago, Ill. Segregated food wastes from refuse averaged 22.4 lb/cu ft. Refuse weighing 20 lb/cu ft or less is assumed to contain very little ashes, and the lighter it is the more paper and metal there must be. Paper has continually increased in refuse, garbage decreased.

The research project, supported by a grant, has 3 phases: 1) development of sampling and analytical methods, 2) study of the physical and chemical composition of refuse in a number of cities, and 3) statistical analysis and evaluation in terms of nation-wide application. Statistical analyses of sampling 1/4-loads of refuse showed the following results with the accuracy in terms of 95% confidence level:

	Paper		Garbage		Metal		Glass		Ashes	
Parameter	Avg.	Acc.	Avg.	Acc.	Avg.	Acc.	Avg.	Acc.	Avg.	Acc.
% weight	60.9	4.31	10.9	2.35	12.5	3.33	10.1	3.14	5.7	0.59
% volume	83.3	2.74	2.5	0.20	10.0	2.35	2.5	0.39	1.7	0.59
Bulk density, lb/cu ft	3.91	0.98	23.8	6.66	7.07	2.35	22.8	5.68	21.9	4.51
% moisture	9.44	1.66	70.1	7.9	--	--	--	--	17.0	4.90
Cal. value, Btu/lb	7498	288	7864	592	--	--	--	--	554	294
% volatile matter	91.2	0.86	87.5	5.68	--	--	--	--	14.9	1.57
% carbon	42.3	6.00	43.3	5.10	--	--	--	--	6.05	0.75
% hydrogen	6.85	1.29	6.34	0.69	--	--	--	--	0.73	0.06

Acc. = accuracy; e.g. for volume of metal, the true value, if a percentage of 15% was found, would be (15± 2.35)% in 95 out of 100 samples of 1/4-truck loads.

294. The statistical studies also showed the number of samples needed to establish the confidence level and accuracy desired (shown on curves). Individual households were also sampled and a formula is presented showing the man-hours required for sampling and sorting into various categories.

Studies on determination of moisture in the separated garbage portion showed that drying at 103°C appeared to give higher results by 2.5% than drying at 40°C. Particle size also effects these values. Attaining constant weight at 35-40°C was impractical and so temperatures were used in steps from 35 to 70°C to compare with the standard drying temperature of 102-3°C insofar as its effect on subsequent chemical analyses could be observed. The 70°C temperature was selected because the weights "came within reasonable constancy". Pre-drying before grinding samples was found to eliminate variation in duplicate samples. Values obtained at 103° and 70°C for lipids, C, H, N, and S showed higher when drying was at 70°C and possible causes of this are being studied.

Two to five percent loss in moisture was found if the garbage portion was ground wet instead of after pre-drying with subsequent completion of drying after grinding. If unground garbage is dried to constant weight, the observed moisture content will be about 0.8 points less than a sample that is first partially dried, then ground, and the drying process completed.

295. Boggiano-Pico, Nicola- Fertilizer from garbage. Ital. 537,793, Jan. 4, 1956. Chem. Abs. 52 (2) 1534f, Jan. 25, 1958.

"A plant is described which, besides the conventional mechanical processing of garbage, involves use of an oxidizing gas, e.g. ozonized air, in an electric field. This is said to activate and accelerate the development of the bacterial flora which leads to fertilizer formation." (CA)

296. Böhme, L.- The composting of settled sludge by the "Natural Composting" process (Kompostierung von Klärschlamm nach dem Verfahren der "Natürlichen Kompostierung".) Die Deutsche Landwirtschaft, Heft 12, reprint, 3pp, Dec. 1957.

Utilization of sewage sludge presents a problem in all towns with sewage treatment plants. Use of fresh sludge is hygienically and commercially objectionable. Digested sludge may not be free of pathogens and worm eggs and does not make a satisfactory fertilizer. If sludge can be composted at temperatures above 55°C (131°F) for a sufficiently long time, pathogens are killed or their activity greatly reduced. Also, chemical changes during composting produce plant nutrients and trace elements capable of ready assimilation by plants.

296. Fresh sludge and dust or other town refuse has been successfully composted by the Indore and Baden-Baden processes. Rohde has also composted fresh sludge with dust or street sweepings at Berlin by the "natural composting" method. This is not practical, however, on a large scale in Berlin because of the high transport costs and the large area required. The author has modified Rohde's process by composting sludge alone in Berlin.

A layer of (raw) sludge 25-30 cm thick is allowed to dry on the drying bed until the moisture is reduced to 65-70%. It is then plowed with the use of a horse. After 8-14 days of additional drying, the sludge is harrowed to break up lumps. After another 8-14 days, when the moisture content has dropped to 50-55%, the sludge is broken up by means of a rotovator. These two operations must be done at the proper moisture content. After rotovation the sludge may be windrowed about 1.0-1.2 m high and 2.0-2.4 m wide. Fungi develop rapidly and temperatures reach about 60°C (140°F) and persist for several days. The compost is turned after 4-6 weeks and will have matured in 6-8 weeks, or 15-18 weeks after the first plowing. These studies are continuing.

297. Braun, Rudolph- The processing and utilization of refuse and sludge (Der Verarbeitung und Verwertung von Müll and Klärschlamm). repr. Schweizerische Bauzeitung 77 (7) 3-11, Feb. 12, 1959 (German).

The Swiss find it increasingly difficult to dispose of sewage sludge and open refuse dumping is all too common. Sludge may be dried and incinerated with the refuse but this is economical only for large cities. Incineration plants exist at Zürich, Basel, Berne, Lausanne, and spa Davos but sludge is not processed at any of these.

Composting refuse-sludge has recently been advocated. Compost works exist at Küsnacht and la Chaux-de-Fonds (Dano egsetor process), at Rüschlikon and Chur (Dano biostabilizer plants), and at Uzwil (Bühler process). While these plants treat refuse alone, sludge could readily be treated with the refuse. These three composting processes are then described and illustrated.

Two additional unique systems are described: the Streit method (Ingenieur-Büro Streit, Geneva) and the SMG-process (Schweiz. Metalurgische Gesellschaft). In the Streit method, refuse is pulverized in a hammermill, dried in a hay-drier, freed of high-density material in a cyclone, and used as a fuel either loose or in briquettes. The SMG-process, developed by the Firmen Pawert und Multibacto, Basel, combines pulverization, drying, and briquetting and composting. Refuse is ground in a Novorotor (made by the firms: Ruckstuhl, Basel and Hazemag, Münster). The vertical air-suspension dryer also classifies the ground refuse which is then either briquetted for fuel or composted with bacterial inoculum in an Earp-Thomas type unit for 24-48 hrs. Both these processes would be amenable to refuse-sludge treatment.

297. Experiments at Uzwil and Rüschlikon indicated that sludge, dewatered to 70% moisture, can be composted in a refuse:sludge ratio of 2:1 which improves the compost over that of plain refuse. Temperature of composting kills the pathogens and weed seeds. Raw or digested sludge may be concentrated to the desired moisture content by a Heymann (Firma Vibratic, Zürich) or a Rhewum (Firma Wartmann, Zürich) vibrating screen. Raw sludge offers greater improvement in composting than digested sludge and the product is hygienically unobjectionable as found by the Hygiene-Institut, University of Zürich.

Costs of incineration and composting are shown in graphs from data of Pöpel. Compost is not yet urgently needed in Switzerland but small towns can generally sell their entire output nearby. Compost is a "soil builder" more so than a "fertilizer", although Swiss agriculturists evaluate it on its nutrient content alone. Considerable discussion is given to values and uses of compost, including experimental results in steep vineyards by Dr. Klenk and in forestry by Dr. Surber. Mention is made of national and international collaboration and of the International Research Group on Refuse Disposal (IRGR), Zürich, founded in 1957, of which Dr. Braun is Secretary.

298. Braun, R. and Allenspach, H.- Experiments in composting refuse and sludge. Schweiz. Zeitschrift für Hydrologie 20 (1) -- 1958; IRGR (6) 10-11, July 1959.

(see IRGR) (see abs. 297)

299. Bridger, Roy- Compost is good for you. Pub. Cleansing 49 (585) 248-50, May 1959.

A recent book "The World of the Soil" by Sir John Russell declares 'progress cannot be halted' but apparently the British generally resist'progress'. The book argues on both sides of the questions pertaining to agriculture, e.g. modern chemicals control pests and diseases but they may also upset Nature's equilibrium of wild life and get into plants and food. Increased use of modern fertilizers leads to deficiency problems and new and speedier machines increase the risk of farm accidents.

Gordon Blackstock, manager of a prize-winning Bapton Shorthorn herd, declares trouble in cattle is due to over-use of artificial fertilizers, especially nitrogen. Hay, grown with little or no artificial fertilizers, is far superior and more readily eaten by stock "than hay which had been over-done with large applications of high nitrogen manures". R. H. Watherston, president of the Shorthorn Society states "Nitrogenized grass is not fit for cattle".

England has 20 million acres of grassland and 17 million more of "rough grazings", totalling 3/4 of the agricultural area. "Yet it is said that there is no scope for municipal compost." The Hampshire County

299. Horticultural Committee is calling for "the composting of municipal wastes 'to provide industry with powerful cheap fertilisers and thereby benefit public health'". There is growing appreciation of the need for "closer integration between agriculture and the public health services".

A leading newspaper, the Manchester Guardian, surveyed the situation and points out "that cultivated soil must be constantly replenished with humus, that in humus and mineral content municipal compost compares favorably with farmyard manure, that the Zuckerman Committee's 'generally uneconomic' verdict was unjustifiably based on the assumption that compost would cost $8.40 per ton to produce, the correct figure for a modern plant being only one-third of this, that in many cases there would be a saving on present methods even if the compost had to be given away, and that in consequence the attitude of the various Ministries concerned is no longer defensible".

There will be demand for refuse compost by farmers, gardeners, and market-gardeners if it were available, "but it is not yet widely available because local authorities are reluctant to install plants while demand remains uncertain".

300. Bridger, Roy- How to deal with town waste. The Times (London) 7, July 13, 1959.

Britain's rivers and coastal waters are so polluted that fish and other aquatic organisms are being driven out, shellfish beds are being rendered unusable, and many seaside resorts cannot guarantee the safety of their bathing beaches. As the Br. Med. Jour. states: 'England is fast becoming a jewel set in a sea of sewage'.

Not all cities discharge untreated sewage. Bradford produces 30,000 T/yr of dried ground sludge fertilizer. But the drying techniques are liable to be prohibitively costly. In some cases sewage farming is used, the world's largest being near Melbourne, occupying 26,000 acres of grazing land. Such area is not generally available, moreover it does not solve the refuse problem. Domestic refuse is generally tipped but again the area suitable for tipping is generally suitable to more profitable use.

The compost heap is likened to 'the floor of the forest rolled up' and this "rolling up" and speeding up can be accomplished in the Peterson 'Dano' Co. (Copenhagen) mechanized composting plant. Sewage sludge requires dewatering while refuse requires moisture addition and in the Dano rotating drum the two can be composted together. In addition, there exists a "vertical silo system" in which prepared wastes drop in stages of 24 hrs through a series of platforms.

Countries short of resources necessarily turn to returning wastes to the land in suitable form. Costa Rica set up a "Corporation of Organic Manures" in 1948, India inaugurated a special "Compost Week",

300. and many States have made composting compulsory. Egypt uses compost from Cairo to reclaim her newest desert province. Bangkok, Thailand, has installed the largest compost plant yet built, designed by the British firm of Compost Engineers. Holland has such great need to maintain the humus content of her soil that debate on the question of composting is now confined to comparisons of various systems. Czechoslovakia prohibits incineration by law and plans construction of 60 new compost works by 1975. The Hungarian government subsidizes municipal composting which operates in 33 cities, including Budapest. Poland is going ahead on similar lines; Vienna composts.

Dano plants exist in Denmark, Sweden, Norway, Finland, Iceland, Britain, France, Germany, Holland, Switzerland, Italy, Saudi Arabia, the United States, Brazil, Ecuador, and Japan. After partial mechanization at Kirkconnel, Dumfriesshire, the first city to achieve an all-mechanized plant in Britain was Edinburgh. The first Dano unit (1955) was so successful that two more larger plants were ordered. Composting experiments have been conducted for years at Leatherhead. The latest British plants are Leicester and Redditch and there is a silo type of plant at St. Helier, Jersey.

The Joint Working Party on Municipal Composting recently issued a report. That application of organic manure is of benefit to crop production is self-evident. Man will do well to see that his sewage and his refuse is distributed and utilized in orderly fashion, conducive to health.

301. Brown, W. F.- Disposal of towns' wastes. Proc. Inst. Civ. Engrs. 8: 409, 1957; W.P. Abs. 31 (4) 855, Apr. 1958.

"The author discusses briefly methods for the disposal and utilization of sewage sludge. The necessary criteria are freedom from nuisance and health hazards, and reasonable economy; the first two make digestion essential in most cases. As much use as possible should be made of the fertilizing value of the sludge, either by application in the liquid state or by composting with dry organic wastes. In Great Britain the commonest method of disposal involves partial drying on underdrained beds, followed by dumping. The effectiveness of this process could be improved by the introduction of mechanical stripping and by covering the beds." (WPA)

302. Brown, William G.- Compost of sewage sludge, leaves, used on park lawns. Amer. City 74 (3) 150, Mar. 1959.

The Park Dept., Bakersfield, California, composts leaves and grass clippings in windrows for 12 months, turning once during the summer with an Allis-Chalmers loader. After decomposition, the material is spread to a depth of 4 ft, ramped at each end, and covered with dried digested sludge by truck. A motor grader blades this over in rows and the materials are mixed with a tractor-pulled Seaman Pulvi-Mixer. The

302. mixture is then hauled to city parks and spread with a power take-off driven manure spreader or to park lawns where it is spread with a tractor-drawn Ezzee-Flo Spreader. Ammonium sulfate, superphosphate, and potash are mixed with the sludge during the mixing and pulverizing operations and the park lawns are aerated prior to fertilizer application by a West Point Grassland Aerifier.

303. (136) Brunt, L. P.- Refuse disposal by composting. Mun. Engg. (Br.) 3640 1111-4, Oct. 9, 1959.

Because of the decreasing availability of nearby sites for controlled tipping (sanitary landfill), the method of composting of refuse is bound to become of increasing interest. It can compete economically with incineration based on experience at Jersey and Scotland. Composting can be used with sorted refuse or refuse and sewage sludge with only a slight increase in operating cost. The latter saves money that would otherwise be spent on sludge handling and drying. Only those exceptional towns with nearby sanitary landfill sites "can afford to defer consideration of the adoption of composting treatment for the time being". Where long hauls are required to landfill sites, towns can consider transfer depots and large-capacity haul vehicles as against composting at closer sites. While salvage may be the same with incineration or composting, only the latter provides a product for soil humus content maintenance.

Compost benefits extend beyond providing humus and include: significant amounts of nutrients for crops; beneficial trace minerals such as boron, iron, manganese; beneficial biological activity which retains soluble nitrogen and other nutrients, preventing losses while making them slowly available to crops; improvement of water-retention capacity of light soils and texture of heavy soils. Compost may be sold directly to farmers or gardeners or by a commercial company under contract.

Preliminary refuse treatment for composting involves: sorting (to remove waste materials and salvage), screening (to remove dust which is stored and reproportioned), magnetic separation, grinding, ballistic separation (to remove inorganics), and mixing (to blend prepared refuse, dust, and water or sewage sludge for optimum composting conditions). The grinder should reduce particle size to about 2-1/2-in. downwards and may be a high speed hammermill or a low speed rasping type (as at Jersey). Ballistic separation may follow grinding or composting. Mixing may be by hand, rotating drum, or stirring equipment. Moisture is important and the maximum content is 65% by weight.

Composting, accomplished by bacteria, fungi, molds, and other forms, is aerobic thermophilic decomposition of organic matter. Proper aeration, moisture, and temperature are provided and organics form the food for energy and metabolism of the microorganisms. It may be conducted in windrows with occasional turning to maintain aeration or in cells or drums with various devices to mix and aerate the compost during the

303. initial hot phase of decomposition. Temperatures above 60°C (140°F) are required for hygienic reasons and are easily attained by the oxidative organisms. With initial mechanical composting, the compost must be stored for a period to mature it. Use of sewage sludge with refuse in composting not only disposes of a troublesome waste but improves the value of compost.

304. Davies, A. G.- Tropical waste needs extra disposal care. Mun. Engg. (Br.) 135: 1289, 1958; W.P. Abs. 32 (5) 896, May 1959.

"The author describes the use of composting for the disposal of sewage, with specific reference to the procedure carried out in Northern Nigeria, and the use of composts as soil fertilizer. Details of the method of composting at Kano are given, and diagrams of the pit used are included. The method is very similar to that of the Indore process; the compost is turned after 5, 15, and 30 days to allow for aeration. The necessity for the complete elimination of fly infestation is stressed, and the advantage of contact of the compost with the earth, or with a concrete base, are described and compared." (WPA)

305. Davies, A. G.- International Congress: a hatful of experts with one aim -- refuse. Mun. Engg. (Br.) 136 (3620) 541-2, May 22, 1959.

An International Congress on Refuse Disposal and Utilization was recently held in Scheveningen, the Netherlands. Representatives of 25 countries participated and papers were presented or simultaneously translated in German, French, and English. Sessions were of 4 hours with visits to Dutch plants in between.

Knowledge on composting is more advanced in Holland, Germany, and Israel than in England. Mr. A. W. van de Plassche, Minister of Agriculture addressed the group on the development and significance of refuse utilization in the Netherlands. About 1930 it was obvious that the soil needed more humus and the VAM (Rubbish Disposal Co., Ltd) was formed and a large compost plant was built to serve the Hague. Agricultural research was increased and it was learned that intense applications of artificial fertilizers resulted in shortcomings or certain deficiencies in the soil and that these could be corrected or supplemented by application of organic matter.

The government is actively interested in further development of the composting process. About 25% of all the urban refuse produced by the Netherlands is converted to compost and used in horticulture or agriculture (350,000 T/yr). The author hopes to pass on other information gleaned from the conference over the next few weeks. (See abs. 308, 328)

306. Davies, A. G.- Report on composting plant, Toulouse, France. pers. commun. 4pp, transmitted Nov. 25, 1959.

A research pilot composting plant was put into service in May, 1956 by M. F. Prat to treat about 28T/day or 8400 T/yr of refuse from a portion of the town of Toulouse. The plant was inexpensively constructed, using makeshift methods and requiring much hand labor. A shed 12 x 43 yards in area houses 10 cells about 10 x 20 x 7 ft high with sides of open-mesh

306. panels, one wall of each being movable. Raw refuse and catalysts are charged directly into the cells, one each day and compost removed after nine days, leaving one cell vacant for emergency. Refuse trucks discharge on the earth in front of a cell, after which a tractor shovel loads the cell and three men level the refuse in layers while it is loaded. Decomposed refuse is removed by tractor shovel to a hopper 65 yards distant for processing.

The catalysts are "formed of blocks of pumice stone superimposed on round steel bars, 10 mm in diameter and 10 feet long, joined in threes". "Prior to their insertion in the cell, the catalysts are immersed in a liquid containing the selected bacteria used for acceleration of fermentation".

Decomposed refuse is belt conveyed past a magnetic separator and electronic detecting device to a hammermill which provides fine grinding. Removed ferrous metal amounts to 3-1/2% of the total refuse and brings in about $3,000/yr or $10/T. The electronic device stops feed to the grinder if any metal is present. There has been experienced considerable difficulty with grinding. The compost sells readily for agricultural use at about $3.64/T. Resulting profit, after deduction of expenses, is 57¢/T. Compost production is 6,720 T/yr, or about 80% of the refuse weight. Eight laborers are required and the cost of royalties for the catalysts amounts to about 40¢/T. Mr. Prat envisages in a permanent plant the cells would be charged directly from above and would be discharged by gravity.

307. Davies, A. G.- Report on composting plant, Calais, France. pers. commun., 3pp, transmitted Dec. 11, 1959. (Translated).

The Calais plant, operated by the City, was put in service in May, 1958, designed for 80T/day or about 220 cu yd/day of crude refuse. Refuse from the receiving bin (2 days' capacity) is raised by travelling grab crane to a feeding bin where it is discharged to a drum sieve with two hole sizes. The fines go directly to the conveyor to compost while the mediums are ground in a hammermill and recirculated to the drum sieve until they become fines. The coarse discharge contains only 2% of the organic portion of the refuse and is discarded. The sieved refuse is magnetically separated (2%), is conveyed, via a stock area, by elevating and pivoting belt conveyors into a "bio-tank". There is no manual sorting and total discard is 10%. The entire process, except for crane operation, is automatic.

The bio-tank covers a portion of a huge circular outdoor windrow, is moved on rails around the periphery, provides forced aeration from a manifold beneath, and contains an overhead sprinkling system. The two ends of the cover give a semicircular shape to the windrow. The tank is filled from the front end and moves forward slowly, continually aerating the windrow within it. Reported temperatures within this covered aerated windrow are 60-80°C. After 20 days, the compost is reported to be homogeneous, finely granulated, odorless, and free from

307. pathogens. (Ed. note: In May, 1959, the editor learned that one year is required for the "bio-tank" to make a complete circuit and the compost behind it appeared to comprise about two-thirds of the circle. The bio-tank appeared to shelter about one-fifth of the circular windrow.) The process is called by the French "accelerated zymothermic fermentation".

For a similar population, 80,000, it is estimated that the plant could be duplicated for $812,000 or $10,150/T of capacity. While the capital cost is high, it has low operating costs for it requires only two men and consumes 7-8 kwh/T of refuse. Production cost was reported as only $1.12/T and compost sells for $3.36/T. The site required is small.

308. Davies, A. G.- Every cleansing officer should study these nine papers. Pub. Cleansing 50 (2) 65-8, Feb. 1960.

This is a short report on the International Congress on the Disposal and Utilization of Town Refuse, Scheveningen, the Netherlands, in April 1959. The author indicates that the British overlooked the meeting as there were only three representatives directly associated with municipal affairs.

The nine addresses "were in no sense ordinary ones, for in every case they were presented by men who have made the subject, or at least their particular aspect of it, a lifetime specialist study". Brief comments are given of papers by Mr. E. Livshutz (Israel), Dr. E. Glathe (Germany), and Mr. S. A. Gothard (England).

The author concludes that the cleansing officer should study every avenue of approach to the refuse disposal problem and should be acquainted with the papers of the Congress. These papers dealt with composting and the use of composts from refuse and sewage sludge. The situation in Britain is not much different from that in Holland and "the occasion now seems opportune for a re-appraisal of our approach to the whole question". (See abs. 305)

309. Davies, A. G.- Waste disposal in Paris. Mun. Engg. (Br.) 136 (3637) 993, Sept. 18, 1959; also: -- Paris model. Pub. Cleansing 50 (1) 45, Jan. 1960.

Three methods of refuse disposal are used in Paris: incineration, controlled tipping, and preparation with immediate dispatch to agriculture. In the latter method, refuse and street sweepings are screened, sorted, and ground, then sold for root crop cultivation and market gardening. The screens are of the rotary drum type with 70mm perforations, the tailings being consigned to incinerators or sanitary landfills. An electromagnate removes scrap iron and tins. The grinder is a hammermill. Production is 10-20 T/hr.

Selling price is 180-270 francs/T depending on the season. Bulk sales of 15-20 T are the rule. Application rates are: for root crop cultivation - 20T/acre, for market garden use - 32T/acre. A rail transport subsidy arrangement varies the annual income, not receivable in case of truck transportation.

309. (Ed. note: A personal communication from Mr. Davies gave additional information on composting in Paris: An Earp-Thomas composting plant was constructed there and ultimately produced compost from refuse on a commercial scale. Bacterial inoculation was practiced. The plant is shut down "for lack of finance and adequate markets for sale of compost".)

310. Davies, A. G.- Compost problem solved by Swiss in Lower Uzwil. Mun. Engg. (Br.) 136 (3637) 990 and 993, Sept. 18, 1959.

The Buhler Brothers Engineering Works at Uzwil has built a refuse composting plant at Lower Uzwil which has been operated about a year with good results. Steps include: receiving, grinding, magnetic separation, vibration screening, roller crushing, fine grinding, and windrow composting with 2-3 turnings for 3-4 months. Features are: enclosed drag conveyors for the ground materials, automatic controls to stop upstream units in case of blockage or trouble, and flow balancing of feed to primary grinder integrated with a raw refuse steel weighing belt. The grinders are of the high-speed hammermill type with heavy swinging hammers.

Last year, 3,600 cu yd of raw refuse were treated, producing 9.3 tons or 1.6% of scrap iron. Volume reduction by grinding was 4:1 with a further 10-20% reduction during composting. Compost has a ready market in local gardeners. Analysis indicates it to be slightly better in quality and lower in moisture than stable manure.

311. Davies, A. G.- The composting of refuse. The Sanitarian (Br.) 68 (1) 19-22, Oct. 1959.

The author disagrees with the Zuckerman Report of 1954. The three alternatives in refuse disposal are controlled tipping, incineration, and composting. The first, being the cheapest, is likely to remain the method of choice as long as sites are available, not always the case. Incineration and composting both require rather heavy capital outlays and, while there may be little to choose between them, the latter "does offer the possibility of a sales income in excess of the salvage anticipation from an incinerator operation".

The author indicates the manurial value of compost to offer much on the basis of two counts: (1) there is much Dutch and German scientific research supporting the agricultural value of compost, and (2) composting is practiced all over the world wherever needs of agriculture have become urgent. In South Africa, where ash and unburnt coal are high in the refuse, some success has still been achieved with composting. Holland and Israel have achieved spectacular results and Tel Aviv is to have a 500T/day plant. "It is clear, therefore, that composting can be important to agriculture both by reason of soil nutrition and the apparent benefit to soil fertility from physical aspects. On the other side of this agriculture picture, I cannot reconcile myself with those who deprecate the use of domestic wastes for agriculture because of alleged disease risk from pathogens, for composting must be accepted as a sterilising process in which the high temperatures achieved provide a safeguard against pathogens."

311. Compost output cannot hope to match the national requirement and there should always be a sale but the price must be related to supply and demand. "Edinburgh, Jersey, and Leatherhead all sell their compost; why should the rest of us fail to do so?" Even with no sale returns "the situation would in no sense be catastrophic" because waste disposal is a public service conducted irrespective of financial return and in the most efficient manner.

There are cases where justification for composting is not strong. Examples are where land is available for controlled tipping and large cities exceeding, say, 200,000 population. Composting is a practical alternative where sanitary landfill has to be discontinued or incinerators become obsolete. The author's own Council (Woking Urban District) intends to operate a pilot composting plant if and when such schemes of this nature become available, even though landfill site potential is not exhausted.

Davies, A. G.- Keeping the soils of Israel alive. Pub. Cleansing 50 (1) 38-40, Jan. 1960.

(Ed. note: This is a summary of data presented in the paper by Shuval, see abs. 372).

312. Dhar, N. R. and Gaur, A. C.- Influence of different phosphates in composting of wheat straw, sawdust, and mixtures of sawdust with straw and dung. Proc. Natl. Acad. Sci. India 25A, Pt.6, 540-9, 1956; Chem. Abs. 52 (22) 20812c, Nov. 25, 1958.

"A study was made of the composting of straw and sawdust, rich in lignin, under different conditions, as well as of the C-N transformations of straw mixed with water in the presence or absence of small amounts of urea kept at 35°C. There was an appreciable N fixation from air (greatest in the presence of phosphates) in the composting of wheat straw, sawdust rich in lignin, and mixtures of sawdust with straw and dung along with small amounts of soil. The C:N ratio of the compost obtained in the presence of phosphates was lower than that of the compost in their absence. The N loss could be minimized if the temperature and acidity of the system were not allowed to rise much. The amount of N fixation from air decreased as the urea concentration increased. The incubation of straw mixed with 50% of its weight of water in glass beakers for three months led to a nitrogen fixation of 37.7% of that of the total N present in the straw." (CA)

313. Editorial- Compost's value overrated. Public Health (Johannesburg) 15: 70, 1951.

"The value of compost is overrated by many according to an article by Dr. I. S. Perold head of the department of biological chemistry at Stellenbosch University, in The Shire and Municipal Record.

"Dr. Perold, who has just completed a tour of New Zealand, said that he was the first person to make compost in South Africa. He believed in all forms of organic matter, but he believed in supplementing it with the necessary chemical fertilisers.

313. "He thought it was very wrong to go to extremes with compost, and the scientific workers in New Zealand were aware of that danger. He did not believe that compost was the alpha and omega in agriculture. Compost and chemical fertiliser went hand in hand.

"The use of sewage in composting could be a most dangerous practice if the process was not very thorough and very complete, he said. Supervision of the work by men who knew their job was essential. The compost had to be matured and free from harmful organisms, and that could be accomplished only by excellent supervision and thorough turning. He was in favour of composting, but those in charge must be careful to see that decomposition was complete.

"No matter how safe it may seem, he would rather not see root crops grown in soil fertilised by the compost, he added. However, it was perfectly safe for crops such as cabbages, tomatoes and peas.

"Dr. Perold said that nearly 200 towns in South Africa had established compost plants, but many had stopped production in the last year or two. They had been condemned by the Department of Agriculture because those in charge did not see to it that the turning of the beds was done properly. (S.A. Municipal Magazine)" (entire article)

314. Fair, Gordon M.- The collection, treatment and utilization of solid wastes: Practice and research in the U.S.A. Wld. Hlth. Org. Bull. 20 (4) 717-24, 1959.

(These notes include USA data on collection, quantities, and methods of disposal of solid wastes. This abstract includes only the data pertaining to composting).

Quantities are:- garbage: 0.2-1.5 lb (median, 0.6 lb); rubbish: 0.5-1.5 lb (0.9 lb); and ashes: 1.0-1.7 lb (1.1 lb). Wider use of canned and frozen foods is decreasing the amount of garbage; greater use of oil and gas for heating is reducing the amount of ashes.

"So far, the composting of refuse has been confined to experimentation and to what may be called plant-scale tests. None of the municipal operations have maintained themselves over any length of time. Apparently the reclamation of a low-grade fertilizer from municipal refuse does not fit into the American economy." The author cites the research work at Michigan State University by Snell and at Savannah by Wiley and Pearce.

315. Foster, William S.- Follow the charted trail. Air Poll. Fnd. (Los Angeles, Calif.) Rept. No. 3, Conf. on Incineration, Rubbish Disposal and Air Pollution, pp45-50, Jan. 1955.

(Excerpts regarding composting only). "Some recommend composting the refuse to produce a marketable soil conditioner. I admire the fine experimental work done here in California in this field, and also at

315. Michigan State College. Yet, I am convinced that it is too early yet for a city to key its entire refuse disposal to this rather entrancing method. Refuse disposal is a subject that affects the health and welfare of your city, and this consideration must not be subordinated to the market value of a commercial product. Dr. M. S. Anderson of the U. S. Dept. of Agriculture told the public works men gathered at the APWA meeting in New Orleans in 1953 that as far as general farm use is concerned, the market for compost is economically hopeless. This leaves only the home gardener and nurseryman as your customers. Moreover, he stated that to be an effective soil conditioner, the compost should be made from good quality garbage. We do not get this in our city collections.' I also look warily on composting projects, remembering those that have had to be abandoned. One at Mount Wolf, Penna., another at Bay Shore, Long Island, failed even though designed and operated with great technical skill. A pilot plant study at Wyandotte, Michigan, experienced serious trouble keeping the material aerobic, and this is necessary if you are going to avoid odor nuisances. Miami, Florida, hopefully expected to adopt a composting program a few years ago, but today is building an incinerator; Oakland (Calif.), the nation's most famous example, is shut down."

Gabaccia, A. J.- Composting waste sludge from pharmaceutical manufacturing. Sew. & Ind. Wastes 31 (10) 1175-80, Oct. 1959.

(see abs. 195)

316. Geraghty, Cecil J. and Kennedy, Richard R.- Treatment of sewage sludge. U.S.P. 2,861,877, Nov. 25, 1958 (to Modoc Peat Moss Co.). Chem. Abs. 53 (6) 5558c, Mar. 25, 1959; W.P. Abs. 32 (9) 1683, 1959.

"Sewage sludge is filtered into a layer of loose, porous, cellulosic material which partially dewaters the sludge. A reservoir was made on flat ground by building up a dike about 2 ft high around its edges. The area of about 50 sq yds had no artificial underdrain but was on sandy soil. Peat moss containing about 35% moisture was spread with a bulldozer over the bottom of the reservoir to a depth of 3-6 in. The area was then flooded with digested sewage sludge containing about 8% solids to a depth of about 15 in. Drainage was permitted laterally through 3-in. pipes placed in the sides of the dike at its bottom on 20-ft centers. After 4 days of dry weather under conditions prevailing in the spring in central California, drying had proceeded to the point that a solid layer formed over the peat. The moisture of the sludge and peat was then about 60%. A motorized garden disk tiller was then run over the reservoir to till the sludge cake into the underlying peat moss. The flooding was repeated and the procedure duplicated. The final product contained about 35% moisture and 3-5 parts of sludge for each part of peat moss by weight. The operation required 20 days and at no time during the process was there an odor nuisance. The analysis of the final product was as follows: moisture 37.94, ash 28.62, total N 1.28, total P_2O_5 0.10, total potash 0.21%. A variety of cellulosic materials may be used other than peat." (CA)

317. Geraghty, Cecil J.- Report on composting emphasizes efficiency. Refuse Removal Jour. 3 (1) 12, 14, 21-2, 24, Jan. 1960.

The author reports development of three processes to cope with disposal problems of garbage, refuse, organic industrial wastes, and sewage sludges. He states that open dumping is doomed, standard sludge drying is impractical, incineration of refuse and sludge are too costly, and sanitary landfill is only an interim solution due to land shortage. Composting is an ideal alternate means but practical, economic means had not been developed. His methods utilize "simple field processes which can be carried out by standard earth-moving equipment at costs no greater than the least costly alternatives, such as sanitary landfill and air drying of sewage sludge". He stresses that composting is "primarily a waste disposal process and only secondarily as a reclamation operation".

The three processes are:

"(1) A process for composting unsegregated garbage and refuse, with or without sewage sludge and supernatant liquor;

"(2) A process for reclamation of so-called non-compostables, such as construction and demolition wastes, tree stumps, and the like;

"(3) A process for composting sewage sludge at the treatment plant, when it is not feasible to utilize the sludge in the garbage composting process."

These are covered by patents and patent applications. (196) (316)

The first involves windrowing of unsegregated refuse with frequent turning by pushing with a bulldozer or front-end tractor loader up and over the windrow cross-wise. The compost is then separated by screening. The method requires covering of the windrows to prevent fly breeding and odors but the author claims the method to be "self covering" as it is conducted on bare ground in the open. A pilot plant has been operated by the Pittsburgh Disposal Service, serving the City of Pittsburgh, Calif. and environs, and treating refuse, street sweepings, garden and park refuse, sewage sludge, and supernatant liquor -- the latter two hauled in by tank trucks.

The second process consists of dumping rubble, stumps, construction wastes, etc. between two windrows of earth, laying of two pipes along the ground, covering the prism-shaped pile with 2-3 ft of earth, igniting the refuse through one pipe by pulling the fire through from the other, allowing the "destructive distillation without added oxygen" to continue, covering any breaks with dirt, and finally flooding with water to cool and incorporating the remainder into a landfill.

The third process is the treatment of sludge-sawdust in a shallow layer, alternately drying, tilling, and flooding on more sludge, finally dozing the "composted" mixture into a stockpile or directly to trucks. The

317. author also suggests, as alternates for sawdust, the use of peat, rice hulls, paunch manure from slaughtering operations, street sweepings, leaves and brush chippings.

The resultant composts are a 'super top-soil' or "high-grade planting mix", the coarse material suitable for agriculture and the screened or ground material suitable for top dressing lawns. An adequate market is claimed in the San Francisco Bay area.

318. Gerretsen, F. C.- On the content and value of trace elements in urban refuse compost. IRGR (6) 1-4, July 1959.

(see IRGR)

319. Ghildyal, B.N.P.- Biochemical changes in the preparation of composts. Agra. Univ. J. Research 2: 27-39, 1953; Chem. Abs. 47 (19) 10163d, Oct. 10, 1953.

"The biochemical changes resulting from aerobic, extra-aerobic, and anaerobic composting of green stalks of jowar (Andropogan sorghum) for 210 days' duration are reported. A reduction of 51, 47, and 38%, respectively, of the total organic matter was found. The losses of total organic carbon were proportional to the total organic matter lost. The total nitrogen remained constant in the early stages and then decreased 16, 20, and 13%, respectively. The fats and waxes decreased 76, 82.7, and 63.4%, while the water-soluble organic matter decreased 80.5, 72, and 67%, respectively. Lignin was only slowly decomposed with reductions of 24, 31, and 28%, while the crude fiber content was decreased by 63, 69, and 54%, respectively." (CA)

320. Gisiger, L.- Composting city refuse and standards of use. Schweiz. Landwirtschaftliche Monatshefte, Nov. 1958; IRGR (6) 9-10, July 1959.

(see IRGR)

321. Glathe, Hans- Biological processes in the composting of refuse. Int. Cong. on Disp. & Util. of Town Refuse mimeo. 17 pp, Apr. 1959; IRGR (7) 8-10, December 1959.

(see IRGR)

322. Godfrey, G. H. and Rich, Herbert- Acid production in composts of sulfur and organic matter. Amer. Fertilizer 92 (11) 8-9, 1940; Chem. Abs. 34 (14) 4850-1, July 20, 1940.

"Results obtained with composts of sulfur and organic matter demonstrate the possibility of using composts of this kind as biologically active acid-producing mixtures. These mixtures not only develop quickly available acidity but also continue to produce this acidity over a prolonged period; thus the effects of early neutralization or excessive leaching are overcome. One pound of sulfur can be oxidized in this way to give 3 pounds of H_2SO_4." (CA)

323. Gothard, S. A.- Mechanized municipal composting -- the Jersey plant. Pub. Cleansing 49 (587) 503-18; discussion 518-20, July/Aug. 1959.

Two objectives of composting are: a) hygienic disposal of a potentially troublesome waste, and b) utilization of that waste. Dry refuse has about 30% moisture while 63-65% is required. Water or, better, sewage sludge should be added. All refuse must be accepted and then the unwanted part removed while the compostable part is pulverized to a size of 1-1-1/2 in. Natural aerobic fermentation with high temperatures will develop if the requisite conditions are provided. The author recommends composting for a few days at temperatures no less than 150°F and then maturing the compost to give desired C/N, pH, and humus.

The Island of Jersey has a resident population of 57,000 and a visitor influx of 35,000. Refuse has been incinerated and sewage discharged untreated. Now a refuse-sludge composting plant is built and sewers with a contiguous treatment plant are under construction. The composting plant is designed for an average of 60T/day and the plant contains the following: receiving hopper, rotary screen (to extract cinders and fine dust), picking belt, magnetic separator, both rasp and hammermill grinders, ballistic separator, subsidiary mill (for farm wastes), mixer (for mixing refuse, ash, and sludge with automatic weighing), 6-floor fermentation tower, windrow maturing and storage area.

Composting occurs one day each in the six cells, then for at least 8 weeks in maturing windrows. Cells are perforated and roughly semicircular in cross-section. For emptying, cell floors are turned over, discharging to the floor below. The plant cost $596,400 with 1958 net operating costs of $1.93/T, compared to incineration costs (1956) of $3.85/T. At full capacity, it is expected net costs will be reduced to $0.77/T. Sludge may be added at no further increase in costs.

Jersey refuse averages 50% compostable, 13.5% dust, 6.8% rejects, 24.5% cinders, 4.9% tins (scrap iron), and 0.3% rags. The compost has about 17% loss on ignition, 0.48% N, 0.35% P_2O_5, 0.18% K_2O, 45% H_2O, and C/N of 15-16.5, all values on a wet weight basis. Compost is used in both agriculture and deep litter poultry raising on Jersey. The paper contains a number of testimonial extracts from compost users.

In the discussion, Mr. Gothard indicated that refuse had increased in amount from a value of 100 in 1953 to 157 in 1957. Mr. N. G. Wilson confirmed that composting in Edinburgh would not pay for itself but greatly reduced the costs and produced valuable humus. Glass is still a problem of removal from compost and research should cover as wide a field as possible. Mr. A. G. Davies indicated that sales resistance of farmers must be broken down by producing evidence of the value of compost. Lord Douglas placed the greater value of compost in gardens or market gardens, next in horticulture. Present problems in composting are engineering and economics. Mr. A. S. Bennie said Scotland is beginning to appreciate the value of compost. Mr. M. Short pointed to the high value of 50% mineral matter in compost. Finally, Mr. Gothard

323. indicated a desire to play safe on temperature. He said there was a high sales resistance from the conservative farmer of Jersey. There is little or no deterioration of compost, even that stored outdoors -- rains penetrate only the outside inch or two and internal heat drives off the moisture. Farmers require demonstration, not talk; they have to learn from experience which means producing compost and letting them try it. Odor troubles at Jersey have been largely corrected. Quick handling of the refuse is required, before putrefaction takes place.

324. Gothard, S. A.- Special technical problems in the processing of urban refuse. Int. Cong. on Disp. & Util. of Town Refuse mimeo. 8 pp, Apr. 1959: IRGR (7) 5-7, December 1959.

(see IRGR) (see abs. 323)

325. Gray, William D.- Household waste disposal. I. Some microbiological aspects of organic waste disposal with especial emphasis upon cellulose digestion. Rhodesian Engineer (Reprint) 30-33, Sept. 1959.

The biological process of digestion renders insoluble organic materials soluble in which form they may be readily utilized by a variety of organisms. There is virtually no organic compound which cannot be destroyed by one or more microorganisms in time. Cellulose makes up about 50% of the plants and is the most abundant organic compound in the world. Destruction of organic wastes center largely around the digestion of cellulose because of its abundance and the difficulty with which it is digested by microorganisms.

Cellulose is much like starch chemically, both being high molecular weight (150,000 to 500,000) polysaccharides both yielding only glucose sugar when completely digested, and both having identical empirical formulae, $(C_6H_{10}O_5)_n \cdot H_2O$, where n = 1000 to 3000. But the glucose units are oriented differently and many organisms are capable of digesting starch while few are capable of digesting cellulose. Some fungi digest cellulose well but the digesting enzyme, cellulase, is not nearly as widespread as that of the starch-digesting enzyme, amylase.

In the composting process conditions should be arranged to favor vigorous growth of the cellulose-digesting fungi. Mixed wastes decompose in stages, the more readily decomposable matter first. The first stage in the process should be anaerobic and involve thermophilic bacteria to (1) decompose such materials as sugars, starch, proteins, amino acids, organic acids, hemicelluloses, and (2) kill insects, eelworms, pathogens. (Ed. note: The author speaks of thermophilic anaerobes as "those which through their respiratory activities...release a large amount of heat." But anaerobes reduce organic matter to CO_2 and CH_4 primarily, while aerobes oxidize it to CO_2 and H_2O, and produce much greater amounts of heat. It is therefore believed he means aerobic thermophilic bacteria).

325. After the first stage there remains largely cellulose and lignin and conditions should be arranged so that cellulose-digesting fungi can grow as rapidly as possible. He suggests about 60% moisture content and good air movement for the "highly aerobic" fungi. Optimum temperature is also very important and a generalized curve is shown which indicates that optimum temperature for growth is very near the maximum (when no growth occurs). The author gives no suggested temperature but points out that it should be determined by trial and one should err on the low side rather than the high side of the optimum. Large amounts of O_2 are used and CO_2 produced by the cellulose-decomposers. The CO_2 should be swept out in a moving air stream to prevent inhibition of fungal growth. The natural biological digestion will proceed at a rapid rate.

326. Hamlin, G. Homer- Bird solves sewage treatment problem at San Leandro operation. Western City (Reprint) p 32, Apr. 1958.

The San Leandro sewage treatment plant could not handle the sludge load during 1956 and a Bird centrifuge was installed on a lease-purchase plan to unload the digesters and permit plant modifications. The unit is 40" x 60" requiring a 75 hp variable speed electric motor. It dewatered the sludge to 25-40% solids content which produced no odor or fly problems and could be readily handled in dump trucks. The centrate contains relatively high solids content, not entirely removed through recirculation in the plant. Probable solution will be an auxiliary settling tank for the centrate.

The unit was purchased and will be used in the future for dewatering all digested sludge on a routine basis. The centrifuge can be used to thicken raw sludge on a controlled basis (depending on machine speed) and is useful for plants with overloaded digesters by reducing the volume of sludge for digestion. When industrial waste is composed almost entirely of paper stock, this sludge can be directly dewatered to conserve digester space and improve digestion of domestic sludge.

The Los Angeles County Sanitation Districts tested the centrifugation of digested sludge at San Leandro, then purchased a similar machine. (See abs. 382)

327. Heymann, Hans- Apparatus for drying sewage sludge. U.S.P. 2,799,398, July 16, 1957. Chem. Abs. 51 (19) 15050b, Oct. 10, 1957; W.P. Abs. 31 (1) 157, Jan. 1958.

"Apparatus for the dewatering of sewage sludge consists of an endless belt of hair sieve or filter cloth, suitably reinforced underneath and supported by pre-tensioned wires to form a vibrating surface on which the sludge is subjected to quickened drying. The effectiveness of the equipment depends on the rate of oscillation." (WPA) (See abs. 374)

328. IRGR - International Research Group on Refuse Disposal.

A complete listing of IRGR Information Bulletins as of Feb. 1960 follows:

Info. Bull. No.	French and German Version	English Version
1	November 1956	May 1958
2	April 1957	October 1958
3	October 1957	October 1958
4	March 1958	February 1959
5	August 1958	March 1959
6	January 1959	July 1959
7	July 1959	December 1959

Supplement 1 of this Bibliography lists articles through Bulletin 5 which appeared in toto, summary, or abstract form in the Bulletins (see abs. 211). As before, articles in Bulletins 6 and 7 are listed herein alphabetically by senior author without abstracts, by English title, with date and pagination of the English version, and with date and language of original article given parenthetically, where available. (English versions of the Bulletins may be obtained from: Public Health Service, Communicable Disease Center, Technical Development Laboratories, P. O. Box 769, Savannah, Georgia.)

IRGR Bulletin 7 is devoted entirely to summarizing the 11 papers and discussions presented at the First International Congress on Disposal and Utilization of Town Refuse, Scheveningen, the Netherlands, Apr. 27-May 1, 1959, sponsored jointly by IRGR, Stichting Compost (Compost Foundation), Amsterdam, and the International Agricultural Centre, Wageningen. This Congress included inspection trips to the compost plants at Delft or Schiedam (choice), Soest-Baarn, and Mierlo, with a subsequent optional tour of inspection to Hengelo, Almelo, Enschede, Dantumadeel, and Wijster. (A limited supply of the set of original papers (English, French, or German) is available for 25 guilders ($6.70) from the International Agricultural Centre, 1 Gen. Foulkesweg, Wageningen, the Netherlands.)

329. Jaag, C.- Present-day problems in composting. Inst. of Sew. Purif., Jour. & Proc. part 4, 436-53, and discussion, 453-7, 1958.

The nuisances, health hazards, and water pollution caused by open dumping of refuse are stressed. Effective municipal waste disposal methods in Europe are incineration and composting, and the bitter struggle between the two does not always lead to the best solution. Refuse disposal planning should include health, economic, technical, and organizational (but not personal) factors. Waste disposal is not a source of income and "every kind of waste disposal plant will remain a financial burden for the community which builds and runs it". Discussion by C. E. Burke pointed out that controlled tipping is much less expensive and more widely used in England than incineration. The author admitted this method to be sanitary but it is little used on the Continent, often pollutes ground water.

329. Refuse amounts average 2.6 lb/cap./day (range: 0.5-5.6). Coal-heating in cold climates greatly increases ash weight seasonally. Whereas European refuse contains 6-9% metal and glass, proportion in the U.S. is as high as 22.5%. Rags, bones, and leather are about the same throughout but paper content in German refuse is much lower than in other European countries. Moisture is about 20-30% and organic content about 44% in Western Europe.

Incineration is used at: Brussels and Monceau, Belgium; Hamburg (2), Germany; Stockholm, Sweden; Paris (3), Toulouse, Nancy, Roubaix, and Bordeaux, France; Rotterdam, Amsterdam, and Dordrecht, the Netherlands; Glasgow, Scotland; Sheffield, England; Gjentofte and Frederiksberg, Denmark; Zürich, Basel, Berne, Lausanne, and spa Davos, Switzerland. Germany recently abandoned all incinerators except the two at Hamburg; Calcutta shut incinerators down for economic reasons; but the new ones at Lausanne and Berne were built because chances of compost sale were very slight.

Incineration destroys organic matter but may be economical in large cities with power as a byproduct. Swiss incinerators cost $5.00/cap. for 500,000 pop., or $12.50 for 75,000 pop., according to Allenspach. Pöpel estimates German incinerators cost up to $22.50/cap. for 140,000 pop., including power production, and $15.00 and $21.50/cap. for 500,000 pop. without and with power, respectively.

The need to increase soil organic matter recently became acute in the Netherlands, France, Germany, and other countries. Not as great a need exists yet in Switzerland but good refuse disposal is demanded. There the principal deterrent to use of compost is not the farmers but the agricultural specialists. Ground refuse is used as hotbed manure in gardening or, after composting, in many agronomic uses. It maintains organic substance, improves soil structure, and provides nutrients and trace elements for cultivated plants. Fairly detailed discussion is given of refuse compost use in forestry and land reclamation, vineyards, and chicken breeding.

As to choice of refuse disposal methods, Pöpel's conclusions are cited:

(a) Salvable materials should always be sorted out (mechanically, whenever possible).

(b) Incineration of low Btu wastes is usually uneconomical or unsuitable.

(c) Anaerobic digestion is cheaper than incineration and methane produced is more easily transported than heat or steam from incineration.

(d) While anaerobic digestion produces essentially more calories than incineration or composting, it may scarcely be considered for domestic refuse due to high capital costs.

329. (e) As composting of solid wastes produces useful humus, requires less capital cost than incineration, and causes no health hazards, it appears to be the "choice solution to the waste disposal problem".

The author describes various methods of composting: Beccari, Dano egsetor, rasping, van Maanen, Bühler, Baden-Baden, and Dano biostabilizer systems. "The addition of sludge enhances the quality of the compost", improving nutrient content and C/N, and the heat of decomposition kills human and animal pathogens, worm eggs, and weed seeds "so that the final product -- the garbage-sludge compost -- is perfect in every respect". To process refuse and sludge from the same population requires sludge thickening to 70-75% moisture content, as by the centrifuge ('Barbara', Hübscher & Co., Schaffhausen), a vibratory sieve (the Heymann system), or evaporation on drying beds. Composting in windrows or stacks is discussed with comments about size, aeration, and turnings.

Many problems need solving and international cooperation is needed as exemplified by IRGR and their Information Bulletins. A point continually stressed is that waste disposal or processing should never be a money-making proposition but that maximum economy is, of course, desirable.

330. Jann, G. J.; Howard, D. H.; and Salle, A. J.- Method for the determination of completion of composting. Appl. Microbiol. 7 (5) 271-5, Sept. 1959; PHEA 39 (12) 10, Dec. 1959.

"Factors have been determined whereby organic debris may be composted in a relatively short period of time. The factors necessary for rapid composting are an alkaline pH, a temperature of 55°C, suitable aeration, and a moisture content of 65 percent. Materials such as pear waste and garbage which contain organic acids and thus have an acid reaction must first be incubated at room temperature where organic acids are destroyed by fungi before being placed at 55°C.

"A simple procedure has been devised whereby it is possible to determine the end of the composting period. It is based on pH changes which take place in organic matter held at 55°C under anaerobic conditions. It was found that the organic material if fully composted or stabilized will maintain an alkaline pH for 24 hr under these conditions. Such a compost will not undergo anaerobic fermentation on storage. 6 tables. 8 references." (authors)

331. Jeffreys, Geo. A.- Simultaneous aerobic and anaerobic composting process. U.S.P. 2,867,521, Jan. 6, 1959. Chem. Abs. 53 (7) 6503i, Apr. 10, 1959.

"Waste organic materials, such as garbage, sawdust, rice hulls, and sewage sludge are composted either in batches or in continuous process to a high-grade humus by bacterial action. Matter which contains much cellulose or lignin is first subjected to the action of fungal molds, such as Penicillium or Aspergillus, for which the optimum pH is about 5

331. and the moisture content about 30%. At the start of the mold stage the temperature should be 30-35°C. Then this mass or a mixture of other waste organic materials is subjected to mesophilic bacterial action at 30-45°C. Optimum conditions for this stage are pH of 7.6, moisture content of 40-70%, and temperature of 60-75°C. A period of thermophilic bacterial action then takes place and the temperature remains at 60-75°C until a drop to 45-50°C occurs, indicating complete conversion. Some bacterial organisms may be added at either of these stages. The final stage is one in which actinomycetes exert a stabilizing action. The temperature and oxidation rate are controlled by aeration. Nitrogen compounds are periodically added. The material is then dried and ground. The period required is about 1 to 2 weeks." (CA)

332. Jennings, W.- Salvage in 1959. The Sanitarian (Br.) 68 (1) 23-29, Oct. 1959.

Salvage in public cleansing has declined since the war due to increased mechanization of refuse disposal, irregular outlets and low salvage prices, and higher wage rates. The Bradford Salvage Officers' Group surveyed 29 local authorities, 26 of which use the sanitary landfill method of disposal and 27 conduct some salvage activity. Results are:

Salvage Item	No. Auth. Salvaging	Quantity Pop./yr. for 1 T.	Average price per Ton	
			Baled	Unbaled
Waste paper	27	48-137	$30.00	--
Tin cans	11	112*	12.60	$1.40-3.00
Scrap iron	20	--	--	(20.00-heavy (5.60-medium
Non-Fe metals	17	18*	--	varies
Textiles	23	461*	--	(50.00-rags (28.00-bagging (8.40-carpets (14.00-string (5.60-bedding
Cullet and glass	1	--	--	--
Bones	0	--	--	--
Rubber tires	7	--	--	5.60-39.20
Garbage	3	--	--	4.10-10.00[x]

*Maximum; [x]Delivered, for raw swill.

Paper must be clean, well-graded, and with a minimum of contraries, although mixed paper sometimes brings more than newsprint. Fiberboard and mixed paper are easily sold and the most profitable items in refuse. Paper is universally baled in either continuous, vertical electrical, or hand balers. Tin cans are the second most profitable but prices vary from "practically unsaleable" to $25.20/T baled. Tins baling is profitable but only 4 of 11 authorities used balers. Storage is good to have

332. so the authorities can "ride the storm of the slump and dispose of their stocks later". Scrap metal (Fe) is unbaled and frequently bulky, i.e. bedsprings. Authorities grading with number of grades were: 12 (none), 7 (2), and 1 (3). Non-Fe metals are increasing in volume but not in weight -- more aluminum and less solid copper and brass. These must be freed of iron. Average number of metals salvaged by the 17 authorities is 4.

Under textiles, authorities salvaged as follows: rags-18, carpets-7, bagging-9, beddings-1, and string-8. But grading may not be profitable in some cases because of the small amount. Cleanliness is again important. Cullet and glass containers of many types were marketable before the war but not now. Bones are generally not salvaged now and the only rubber item salvaged is tires. Salvage is essential for those authorities with separation plants but is of secondary consideration with sanitary landfill disposal. The author predicts a continual decline in value of salvage items other than paper products.

333. Kaibuchi, Y.- Researches on the composting of refuse and garbage in Kobe City. Sewerage Dept. (Kobe City, Japan) Report, 40pp, Oct. 1959.

The Japanese government and WHO sponsored a research project on composting of nightsoil and refuse at Kobe City. A pilot plant was placed in trial operation in March 1955. It was a 4-deck Earp-Thomas type digester designed for 25T/day, preceded by a hand-sorting platform and a horizontal swing-hammer grinder, constructed at the suggestion of Dr. J. R. Snell. Difficulties were encountered as follows: the grinder clogged easily and had excessive hammer wear; the cone-shaped hopper atop the digester permitted bridging action not corrected by either a screw or an electric vibrator; bridging occurred between plows of the digester; initially, detention in the digester was wrong and a 3-speed drive was necessary; original arms and plows had to be replaced with stronger ones; numerous breakdowns occurred; and the digester capacity was much less than designed. However, 22 experiments were performed with the continuous flow digester. Stabilization was incomplete in the 2- to 3-day detention period and temperatures seldom exceeded 60°C (140°F). Although coliform organisms decreased in the upper decks, they tended to increase again in the lower ones.

Basic refuse contained: 30-70% vegetable and putrescible matter; 5-30% paper; 10-40% soil; 1-5% straw; 0.1-1% metal; 1-3% glass and ceramics; 1-10% wood; and 0.5-2% textiles. This was composted with various parts of seeding material (compost) and/or nightsoil. Moisture decreased usually during composting and the C/N was reduced from 24-30 to 19-28. Decomposition was about 30% in the digester. Optimum initial moisture was about 55%. Use of forced air instead of natural ventilation showed no improvement. As much as 3:4, nightsoil: refuse, could be composted under proper conditions. Crude fiber was decomposed in the digester at less than half the rate of the other organic materials but, subsequently in windrows, decomposition of crude fiber was 23.3% compared to 4% for the remaining organics.

333. Windrow composting experiments were carried on simultaneously. These were run some 20 days, one with 10 turnings and one with none. Moisture became too low in the first run (19.5%) but higher temperatures were attained throughout and decomposition appeared to be somewhat better than in the second run. Bad odors emanated from the windrows.

Some 55-gal drums were used for aeration bin experiments. At aeration rates of 0.5 and 1.0 cu m/hr, the losses in organic matter were 18.8% and 40.7%, respectively. Curing experiments were conducted in 55-gal drums with aeration. Amounts of air were again found to be important, the best rate being 1910 ml/hr/100 g organic matter which also gave the highest temperature (72°C or 162°F). Too much air caused excessive cooling. The objective of the curing bins was to save on digester capacity by reducing the detention period.

A proto-type plant with a Crane-type digester, horizontal semi-circular cells with a modified screw in each cell to mix material and push it slowly forward, was next tested. Units consisted of: feeder, conveyor for segregation, verticle swing-type hammermill, storage bin, nightsoil tank, conveyor, 3-tier digester with blower, and aerated curing bins. This plant was completed in August 1956 and was designed to handle 20 T/day of sorted and ground refuse plus 10 T/day of nightsoil with a 2-day detention period. It was planned to recirculate 10% at each stage or tier.

The second plant gave the following difficulties: grinder capacity was only 2-3 T/hr instead of the designed 7 T/hr; hammer blades wore down very fast; although the storage bin had a discharge feeder table, material bridged in the cone-shaped bin and it had to be by-passed; the plows in the digester operated too slow and broke often; digester parts (plows, center shaft, reduction gear) were all too weak; capacity was only 7 T/day of the ground material.

A "final" revised plant is proposed as an alternative to the present proto-type plant but still of the Crane type. Considerable capital and operating cost data are given for the "final" plant which the Ed. believes to be quite premature. The report has many tables, graphs, and pictures; it summarizes 6 reports previously submitted to the World Health Organization.

334. Keeble, D.H.L.- Household waste disposal. II. Mabelreign's household waste disposal problem. Rhodesian Engineer (Reprint) pp 33-39, Sept. 1959.

An insanitary open, burning dump was used by the Town of Mabelreign for refuse disposal. All refuse was weighed and sorted for a week from the town of about 6,900 population giving: 47,080 lb. of refuse with average density of 11 lb/cu ft, including: 3.2% bottles, 0.5% bones, 4.1% metal, 9.2% paper and cardboard, 1.0% rags, and remainder 81.7%. Alternate methods of disposal were considered and composting was selected because of low soil fertility in the Federation and cost estimates. Of the various composting processes, a new untried process, known as the Tollemache

334. process, was selected. A pilot plant of the Tollemache system appeared to give satisfactory operation and, after a design and estimated cost were prepared for a 60,000-lb/week plant, the Town Board approved a contract for construction which contained certain guarantees of performance.

Process steps are: receiving and storage (1-day), picking belt, magnetic separator, paper and tin baling, raw sewage dosing, "silo" composting, compost maturing in heaps. The "silo" consists of a horizontal concrete unit with a drained floor, a rail-mounted turner agitator, and forced air ventilation through the drainage system. Two such "silos" were constructed at Mabelreign with a turner aerator and cross-travel cradles. (The rail-mounted turner aerator apparently runs lengthwise, picking up and depositing the composting matter, and operates in both "silos.") The plant was accepted in May 1959 and operates satisfactorily except that pieces of non-compostable material (polyethylene, milk bottle caps) are objectionable. It is planned to install a "silorator" which will cut up such material and blow the compost 40 to 50 ft. to a stockpile. Compost sales are good at $9.80/ton ex plant or 14¢/lb in bags. Salvage sales have not been as high as anticipated and there is no market for rags or tins. The composting plant cost $15,680 which, with accessories, buildings and contingencies, totalled about $29,680. Operating costs and receipts are not yet stabilized. Compost temperatures of 150°F have been reached in the silos. (See abs. 291)

335. Keilling, J.- A contribution to the evaluation of organic fertilizers. IRGR (7) 20-21, December 1959.

(see IRGR)

336. Kennard, D. C.; Chamberlin, V. D.; Moore, E. N.; Winter, A. R.- The use of compost (built-up) litter in chicken houses. Ohio Agr. Exp. Sta., Wooster, Res. Bull. 843, 31pp, Oct. 1959.

"The use of compost floor litter for chickens has been subjected to the studies of many research workers. In view of the fundamental and extensively applied research results obtained and its wide use by poultrymen, compost litter can be considered safe and economical for chickens of all ages. Compost litter is sanitary in that its use results in lower mortality of broilers if brooded on it rather than on frequently changed litter from one day of age.

"Compost litter permits broilers to immunize themselves to coccidiosis by intake of coccidia oocysts from the litter before they reach the most susceptible age for the disease. The feeding of a coccidiostat to chicks brooded on compost litter affords additional protection against losses due to coccidiosis. Parasite infection is present among broilers brooded on compost litter but is not harmful as measured by growth rate, feed utilization and mortality. Compost litter destroys Salmonella bacteria quicker than new litter.

336. "Compost litter supplies riboflavin, vitamin B_{12} and lessens the need for protein. Compost litter supplies one or more unknown growth factors. The use of compost litter reduces labor and litter costs. Once compost litter becomes established no additional litter needs to be added. Instead some of the litter will need to be removed occasionally to keep it within convenient bounds. However never less than four to six inches of the litter should be left on the floor for continued use. The addition of superphosphate to compost litter is a desirable means of reducing objectionable odors, reducing the loss of nitrogen as ammonia and maintaining a higher nitrogen content (fertilizer value) of the litter.

"As a fertilizer, broiler compost litter was found by Bentley et al. to contain four to five times more nitrogen than cow manure. Likewise it contained ten times more phosphorus and four times more potash. These three fertilizer ingredients alone had a commercial fertilizer value of $20 to $25 per ton of compost litter.

"Compost litter keeps poultry houses warmer and the floors dryer than when the litter is changed frequently. However, adequate ventilation should be provided where compost litter is used.

CONCLUSION

"The use of compost litter in chicken houses for starting, growing, laying and breeding stock is an economic practice. The use of a coccidiostat in the ration for young chickens and the known vitamin and protein requirements in the chicken rations are recommended, even though they are kept on compost litter." - (Authors' summary) 18 tables, 84 references.

337. Kiess, Friedrich and Schreckegast, Carl- A new economical method of sludge dehydration. Gas- u. Wasserfach 99: 1121-4, 1958; Chem. Abs. 53 (4) 3556h, Feb. 25, 1959.

"Outdoor sludge drying beds require considerable space and are not reliable in wet weather. In the past mechanical dehydration plants have been expensive to operate. Much more economical operation is secured with the Brüninghaus method, in which trash is removed from the sludge by rakes; the sludge is then screened and the effluent passed over a series of fine filters (wire mesh). Both screens and filters are vibrated by means of electrically operated vibrators. The material held on the screens and filters is combined and passed through a roller press to yield a material containing 60-65% water, suitable for agricultural use, disposal by burning, etc. Cost data are given for German conditions. (CA)

338. Knight, G. E.- Straw sludge composts for a rural area. Water Waste Treatm. Jour. 7: 173-4, 1958; W.P. Abs. 32 (7) 1274, July 1959.

"At a sewage works in the North Cotswold rural area, compost is prepared from sludge and straw. Alternate layers of straw and liquid sludge are

338. built up, and thoroughly soaked with water to wash some of the sludge into the straw. When a bed is completely filled, in about 10 weeks, it is left for a month to dry out, and the compost is then deposited in a stack and left for 3-6 months for decomposition and further drying. This compost is deficient in potash, and this should be added in the form of a fertilizer." (WPA)

339. Knoll, K. H.- Composting from the hygienic viewpoint. Int. Cong. on Disp. & Util. of Town Refuse. Mimeo.12pp, Apr. 1959; IRGR (7) 10-12, December 1959.

(see IRGR)

340. Komline, T. R. and Trubnick, Eugene H.- Raw sludge dewatering costs. Wastes Engg. 31 (2) 95, Feb. 1960 (Highlights).

Vacuum filtration costs, including chemicals, labor, power, water, maintenance and ultimate disposal of raw sludge, excluding drying or incineration, in plants of 9,000 to 43,000 pop., vary from $10 to $16/ton of dry solids handled, or 29 to 58¢ per capita per year. About half the cost is for chemicals. Unit costs decrease with larger plants. In comparing costs of dewatering raw sludge with digestion and air drying, it has been found that the latter have been underestimated. Kalamazoo reported costs of digestion with drying bed and lagoon operation to be $4,000/mo at the plant serving 75,000 pop. and treating 250 tons of dry raw solids/mo. This represents an average cost of $16.50/dry ton and, allowing $3/dry ton for return from sludge gas, the net operating costs are $13.50/dry ton or 55¢/cap./yr.

341. Kortleven, J.- Long-term effects of urban refuse compost. Int. Cong. on Disp. & Util. of Town Refuse. Mimeo. 5pp, Apr. 1959; IRGR (7) 16-18, December 1959.

(see IRGR)

342. Krige, P. R. and van Zyl, J. P.- Brief review of the development of municipal composting in South Africa. National Inst. for Water Research, Mimeo. 4pp (undated).

The history of composting and the use of compost, artificial fertilizer, and various manures in South Africa are given. Sheep manure, called Karoo-manure and kraal-manure, is used extensively and analyzes: organic matter - 40%; K_2O - 4%; N - 1.5%; P_2O_5 - 0.5%; and water - 50%. Starting in 1939, J.P.J. van Vuuren, Dept. of Agr., urged towns to combine nightsoil and refuse and compost the mixture in open pits. In due course 120 schemes of composting, using the van Vuuren and other designs, were in operation, mostly in small towns. But by 1951 only a few were producing small quantities of compost. Reasons were: labor costs, fly breeding, poor quality of refuse, siting to avoid odor nuisances, and uncompetitive price. Although compost price had risen from 5 to 25 shillings/ton, the costs of production were even higher and the compost value was no more than that of the Karoo-manure. Since 1952 interest

342. in composting has increased in order to add humus to the soil and the old pit method has been discarded. Other schemes of composting were investigated and, in 1954, the S.A. Council for Scientific and Industrial Research, with funds from the government and many municipalities, began systematic research on composting.

The rotating drum principle is being used and a test plant with 32-ft long x 10-ft diam. drum is being operated. Forced air is provided through nozzles that are automatically cleaned. The plant is in Pretoria and, although good composting is achieved, the compost is of poor quality. Mechanical aspects of the drum are satisfactory except that the outlet gate is not functioning properly. No reliable data have yet been collected on the costs aspect.

343. Lindell, O. V.- Worldwide distribution of rasping machines in composting plants. Pers. comm., transmitted Mar. 9, 1960.

The Rasping Machine, or Refuse Treator, originated by VAM and made by Dorr-Oliver, Inc., is a slow speed grinder or rasp-sieve, designed for grinding refuse. The following list shows the locations of installation at composting plants. Population served in thousands, number of units (where more than one), and the addition of sludge (s) or nightsoil (ns) are indicated parenthetically. All plants, except the Mierlo and Jersey plants, use the so-called rasping system with composting in windrows after sorting and grinding.

EUROPE		ASIA
The Netherlands	Germany	Israel
Almelo (50)	Blaubeuren (20+ns)	Tel Aviv (350-6 units)+
Arnhem (120-3 units)*	Heidelberg (80)	
Delft (80-2 units)	Stuttgart (80)*	
Deventer (45)		
Hengelo (50-2 units)		NORTH AMERICA
Mierlo (450)#	England	El Salvador, Cent. Amer.
Schiedam (80)	Jersey, C.I. (57+s)@	Santa Ana (?-1 unit)*
Sneek (25)		
Vlissingen (30)		

* Under construction. # van Maanen system.
\+ On order. @ Jersey system.

344. Livshutz, Alex- Economic process for disposal and utilization of town garbage and refuse. Manuscript, typed 5pp, (forwarded Feb. 18, 1960).

The author decries the high cost of mechanized composting plants and indicates that compost plants can be made profitable if constructed and operated inexpensively. To accomplish this, he proposes a method of forced aeration windrow composting in which the upper two-thirds of the windrow is covered with plastic. Grinding is recommended, followed by windrow composting. The adjustment of pH to around 7.0 and of C:N to about 30 is recommended. Optimum moisture is 40-50% and moisture is added by means of perforated pipes laid along the length of the windrow with the holes down.

344. The forced air system consists of a portable centrifugal blower, 2- to 3-in. diam. aluminum manifolds running beside the windrows, and 3/4- to 1-in. galvanized pipe laterals 2-1/2 m long and with 50 holes of 1-2 mm diam. in each. The laterals have bayonet couplings and are fastened to bayonet tees in the manifolds at 1-m intervals. They are first pushed into the bottom of the windrow then connected to the manifold. The manifold is connected to the blower by means of flexible plastic or rubber hose. Opposite ends of the laterals and manifolds are plugged. Windrows are 3 m wide at bottom, 2 m wide at top, and 120-150 cm high, of any desirable length. Forced air may be applied continuously, intermittently, or only to those parts of the windrow requiring aeration.

Windrows are turned only twice, whereas 5-7 turnings would be needed without forced aeration; and composting is claimed to be faster. The plastic cover makes heat and aeration more uniform and permits better control of moisture.

Advantages claimed are: 1) portable; 2) even air distribution; 3) preheated air (from the compost itself); 4) specific aeration as needed; 5) continuous or intermittent aeration; 6) easy to insert laterals; 7) pressure regulates aeration; and 8) high aeration can be used to dry compost.

345. Livshutz, A.- Production and utilization of urban refuse compost in subtropical countries. Int. Cong. on Disp. & Util. of Town Refuse. Mimeo 5pp, Apr. 1959; IRGR (7) 18-19, December 1959.

(see IRGR) (see also Shuval, abs. 372)

346. Martin-Leake, H.- Wealth from wastes: (1) Destruction instead of conservation; (2) The case of methane gas. (Source unknown)

The author advocates the use of composting for disposal of refuse and digested sewage sludge, thus producing two products: compost and methane gas. He argues that compost will offset the cost of refuse disposal and possibly result in a profit. The Zuckerman Committee argues that the amount of compost producible is insignificant as far as serving the land's need for organic manure. But the author does not agree that composting should be condemned on these grounds. The Dano process has been successful at Edinburgh and additional units have been installed. The process at Jersey "finds no counterpart in this country (U.K.)". The author fails to see the reasons for demanding more experimentation or for continuing to install new sewage works that are costly. Sewage sludge is unacceptable to farmers and costs of sewerage works are deplored.

Most sewage plants fail to make full use of methane gas produced by sludge digestion. On one hand, coal-burning is being converted to oil-burning, while on the other, electricity is being advocated to save on oil. Cheap power is available from the waste treatment by use of methane, not only to run the plant machinery, but for the community.

347. McKinnie, Murray B.- A new way to handle sludge -- compost it with wood shavings. Waste Engg. 30 (6) 318-9, 342, June 1959.

Santa Rosa, Calif., with 30 in. of rain Nov. to May, required additional sludge drying beds and investigated the Geraghty process. In May 1958 a contract was made for the composting operation for one year. Shavings were spread over dried harrowed sludge and wet sludge was added. After partial drying and harrowing, additional sludge was added, and the process repeated through 5 applications. The bed area used was less than half that required for normal sludge drying alone. Other materials, instead of shavings, were also used, such as street sweepings, leaves, and water buttercup. Also some poor supernatant liquor was treated in the same manner as sludge. The author believes that the City of Santa Rosa has spent their money wisely in handling the sludge problem. (See abs. 317)

348. Merz, Robert C.- Utilization of liquid sludge. Wat. & Sew. Wks. Nov. 1959; Pub. Wks. (abs.) 91 (1) 135-6, Jan. 1960.

Primary sludge from the San Diego, Calif. plant has been elutriated, vacuum filtered, and dried. The city, with the Univ. of Calif., is experimenting on wet application to land to save money. Loadings of 10-100 tons of dry solids/acre by wet digested sludge indicated that land disposal was practical. All sludge is now applied to land and the cost reductions amount to $16.12/ton of dry solids or $48,400/yr.

349. Meyer, J. H.- Some practical results with compost in vegetable gardening. Schweiz. Garten-Blatt 79 (46) -- 1958; IRGR (6) 11, July 1959.

(see IRGR)

350. Müller, Wilhelm- Fertilizer. Ger. P. 856,743, Nov. 24, 1952. Chem Abs. 52 (10) 8437g, May 25, 1958.

"Cleared fresh sewage water is sprayed on a mixture of 80% organic refuse and 20% rubble deposited in a closed fermenting room. An aerobic fermentation process is effected by aeration of the mass. Humidity in the room is regulated by hygroscopic agents (concentrated H_2SO_4). Pressure and temperature balance is maintained by ventilation systems. After 4-5 days the mass is crushed and sieved, $FeSO_4$ is added, and anaerobic after-fermentation allowed to take place for 2-3 days. The final product has a fertilizing power comparable to stable manure." (CA)

351. Naef, H.- Is the refuse typhoon suitable for Swiss conditions? (discussion of article by E. O. Reidel). IRGR (6) 11-12, July 1959.

(see IRGR) (see abs. 365)

352. Neveaux, M.- Processing and agricultural utilization of urban refuse in France. Int. Cong. on Disp. & Util. of Town Refuse. Mimeo. 21 pp, Apr. 1959; IRGR (7) 19-20, December 1959.

(see IRGR)

353. News item- New refuse work by APWA group. Refuse Removal Jour. 2 (7) 27, July 1959.

"A companion volume to 'Refuse Collection Practice' is now in preparation by the Refuse Disposal Committee, Amer. Pub. Wks. Assn. The forthcoming manual will be called 'Municipal Refuse Disposal', and the committee's recent meeting in Washington, D. C. marked completion of a 700-page draft of the manuscript.

"The 10-member committee is helped by a task force of 30. A field study of refuse disposal in 12 cities (US) during 1958 has been incorporated in the project. Committee members are: C. A. Rogus, Chmn., E. R. Williams, Sec., T. E. Winkler, Carl Schneider, Leo Weaver, J. L. Vincenz, W. A. Xanten, J. R. Snell, Abraham Michaels, and B. J. Geisheker." (entire article)

354. News item- Recommend compost. Refuse Removal Jour. 2 (7) 19, July 1959.

"Composting has been recommended to the City of Baton Rouge, La., as a method of municipal refuse disposal. The recommendation was a significant feature of a comprehensive 200-page report submitted to the city by Michigan Associates, Consulting Engrs. and Archs." (entire article)

355. News item- Tacoma discontinues composting operations. Amer. City 73 (7) 35, July 1958.

"Although refuse composting is successful from an economical point of view in some foreign countries, it is unable to compete with other forms of disposal in the United States. In 1953 the City of Tacoma, Wash. initiated a series of experiments on composting refuse. These experiments have been discontinued. Although Tacoma officials felt that the cost of the composting operations was reasonable, they also felt that a continuous and profitable market of the final compost must be assured before production could continue.

"Following is a brief summary of the composting method used by Tacoma: 1. Raw material, consisting of garbage and some sewage sludge was windrowed directly from collection trucks in rows 5 to 6 feet high. 2. Caterpillar tractors turned the material twice a week. 3. After approximately eight weeks, the entire mass was passed over a vibrating screen. Practically 100% of the composted material passed a 1/4-inch screen. The remaining material consists of glass, tin cans and other more or less inert material." (entire article) (See abs. 102,259)

356. News item- Garbage feeding control status. APWA News Letter, 27 (1) 14, Jan. 1960.

"The U.S. Dept. of Agriculture reports that as of Oct. 1959 there were 10,376 premises in the country where garbage is fed to swine. The garbage is cooked prior to feeding for swine disease control on 9,876 of

356. these premises. According to the Dept., less than 36,000 of the well over one million garbage fed swine in the U.S. are fed raw garbage. Thirty of the 50 states report 90 to 100% monthly inspection of garbage feeding premises." (entire article)

357. News item- APWA News Letter 27 (2) 14, Feb. 1960.

"A fully mechanized composting plant designed to handle some 500 tons of garbage a day and costing about $980,000 is in course of erection at Tel Aviv, Israel." (entire article) (See abs. 372)

358. News item- Proposal for composting refuse sought by Phoenix, Arizona. Pub. Wks. 91 (3) 180, Mar. 1960; and- Ask bids for composting Phoenix refuse. Amer. City 75 (3) 161, Mar. 1960.

"The City of Phoenix, Arizona, has issued an invitation for proposals for an agreement with an individual or corporation for the disposal of garbage and trash utilizing the composting process. Salvage of such items as have resale value will be permitted, and proposals for the destructive distillation or carbonization of tree trunks, tree limbs, and shrubbery in conjunction with a composting operation will be considered. The following points will serve as a guide to anyone interested in submitting a proposal for refuse composting:

"1. The City plans to retain garbage and trash collection operations in residential areas. A private company has a franchise to collect refuse in business districts.

"2. The composting facilities, including salvage operations, would be constructed with private capital. The City now generates approximately 600 tons of refuse per day. Proposers must certify that they would be able to compost and dispose of at least this amount daily, and the ability to handle 900 tons daily when required.

"3. The City would agree to dump garbage and trash collected by City forces at the composting plants, and would pay the individual or company approximately the amount it now costs the City to operate the landfill. The payment would be computed as a specified sum per ton of refuse hauled and dumped at the plant.

"4. Composting facilities must be strategically located insofar as the City's convenience of hauling refuse is concerned.

"5. Three composting plant sites not to exceed 10 acres each would be furnished by the City.

"6. The City would expect to participate in the gross or net income of the venture.

358. "Further details and a copy of the invitation to submit proposals may be obtained from Ray W. Wilson, City Manager, City Hall, Phoenix, Arizona." (entire article)

359. Peel, C.- The public health and economic aspects of composting in tropical Africa. Sanitarian (London) 67: 238-45, 1959; W.P. Abs. 32 (7) 1275, July 1959.

"The author discusses the need for improving food production in tropical Africa in view of the increasing population, and stresses the value of composting in reducing faecal-borne diseases and enabling all that is valuable in waste products to be returned to the soil. The objections which have been raised to composting on the basis of public health hazards are discussed and examples are quoted from various parts of the world to show that there is little danger to public health if the process is properly organized and supervised. A description is included of the composting technique and the composting chambers which have been used successfully in Nigeria for several years. The factors to be considered when selecting a composting system are mentioned and it is recommended that preliminary tests should be made with a pilot-scale system. Although the climate in some parts of Africa may appear unsuitable for composting, the composting heaps or chambers can be suitably modified by roofing or screening. The costs of installing and operating a composting system are compared with those of incineration." (WPA)

360. Peyer, E.- Trials in erosion prevention in vineyards and their evaluation. Schweiz. Zeitschrift für Obst- und Weinbau 67 (24) -- 1958; IRGR (6) 9, July 1959.

(see IRGR)

361. Pfeiffer, E. E.- Comments on the construction of grinders for urban refuse. IRGR (6) 4-7, July 1959.

(see IRGR)

362. Pöpel, F.- Recent developments in the technique of refuse processing. Int. Cong. on Disp. & Util. of Town Refuse. Mimeo. 33pp, Apr. 1959; IRGR (7) 3-5, December 1959.

(see IRGR)

363. Quastel, J. H.- Influence of organic matter on aeration and structure of soil. Soil Sci. 73 (6) 419-26, June 1952.

"It is now well known that organic matter plays an essential role in securing in soil the structure, or tilth, that is required for high fertility. In fact, maintenance of the supply of organic matter to arable soils is of the greatest practical importance, for productive capacity

363. is largely dependent upon it." There is a dynamic balance between soil microorganisms and the continually decaying organic matter in the soil such that the C/N remains remarkably constant at about 10. The rate of decomposition varies with temperature, pH, aeration, water availability, and soil mineral content -- the same factors that also influence plant growth. Decomposed organic matter in soil has physical and chemical properties determining soil structure and influencing its fertility.

The complex mixture, humus, is produced in three ways: by bacterial attack on cellulose, by chemical transformations of lignins, and from fungal mycelia. Important constituents of humus are the polyuronides and uronic acids present in plant residues and composts. They are important in the aggregating effects on soil particles and moisture-retaining capacity. Alginic acid, one of the polyuronides, has a marked effect on soil aeration.

The author developed a technique of direct measurement (with a Warburg apparatus) of oxygen available to microorganisms or plant roots in the soil. One percent sodium alginate, added to a heavy clay soil depleted of organic matter, increased the aeration factor from 29.4 to 67.9 at 50% soil moisture content and that of garden soil from 83.2 to 112.0. Also, the water-holding power of a standard soil was increased from 36% to 58.5% of dry weight by a similar addition of alginate.

Additions of farmyard manure and composts greatly improve air-water relationships and crumb stability of the soil, due to both physical and chemical effects. Their use is "dependent on the rate at which they decompose in soil and lose their improving properties". Synthetic soil conditioners may have the same effect if they can be developed and are devoid of toxic effects, do not interfere with microbiological equilibria, and are constituted to withstand rapid breakdown in the soil.

364. Reeves, James B.- Sanitary aspects of composted sewage sludge and sawdust. Sew. & Ind. Wastes 31 (5) 557-64, May 1959.

The author, working with the City of El Paso, is conducting a project (with assistance of a PHS Research Grant) to study the survival of pathogens in the composting of digested sludge-sawdust mixtures at the city sewage treatment plant. He reviews the literature on pathogen survival in various types of domestic sewage sludges. This study is limited principally to isolation of Salmonella and Shigella organisms. Sludge from primary and secondary treatment is digested for 45-90 days and partially dewatered in drying lagoons for 4-6 months. It is then mixed with hardwood sawdust and windrow composted, being mixed and turned by repeated folding over with a road grader. After 2-3 months of composting, the material is ground in a Royer shredder, mixed, wetted, and placed in piles for an additional 2-3 months.

364. Samples, taken with a standard soil sampler, are subjected to the standard presumptive test for coliforms, the membrane filter technique for coliforms, the 24-hr 35°C agar total plate count, and to Salmonella and Shigella culturing and isolation. The two pathogens are cultured first in Bacto-Selenite 'F' and Bacto-tetrathionate broths, respectively. Criteria representing Salmonella are determined by various enrichment media and examined for the following characteristics: 1. gram-negative bacilli; 2. non-spore forming; 3. motile; 4. biochemical reactions; a) lactose negative, b) sucrose neg., c) salicin neg., d) glucose acid and gas, e) maltose acid and gas, f) rhamnose acid and gas, g) dulcitol acid and gas, h) mannitol acid and gas, i) xylose acid and gas, j) indole neg., k) acetylmethylcarbinol neg. Criteria for Shigella were: 1. gram-negative bacilli; 2. non-motile; 3. non-spore forming; 4. biochemical reactions: a) acid and gas only from the various carbohydrates and alcohols, b) indole production variable.

Sixty-one strains of Salmonella and 12 of Shigella were isolated from the air-dried sludge-sawdust compost. However composting temperatures were not recorded in the tests. There were no apparent effects of compost moisture content, ambient temperature, total plate counts, or coliform densities. The ease with which the two genera were isolated is "presumptive evidence of the dangers involved in the possible dissemination of disease through the use of composted sewage sludge as a humus". (Ed. note: It is quite possible that lethal time-temperatures were not attained during composting due to lack of adequate food to support spontaneous thermophilic decomposition. Neither digested sludge nor sawdust is highly putrescible.)

365. Reidel, E. O.- The refuse typhoon, a mobile processing plant. IRGR (6) 8-9, July 1959.

(see IRGR) (see abs. 351)

366. Rudat, K.-D.- The destruction of pathogenic microorganisms and worm eggs during the "natural composting" of settled sludge of the Berlin irrigation fields. Zbl. Bakt. I, Ref. 169: 359, 1958; W.P. Abs. 32 (10) 1884, Oct. 1959.

"A report is given of a paper presented at a meeting of the Österreichische Gesellschaft für Mikrobiologie und Hygiene in February 1958. A process of 'natural composting' has been introduced whereby the sludge of the Berlin irrigation fields is composted on the spot without any additions. Temperatures high enough to destroy pathogenic bacteria and prevent development of worm eggs are reached. Experiments with highly virulent bacteria are described and the economics of the process are discussed." (WPA)

367. Sauerlandt, W.- The influence of organic fertilizers on the uptake of mineral nutrients by plants. Int. Cong. on Disp. & Util. of Town Refuse, Mimeo. 7pp. Apr. 1959; IRGR (7) 12-14, December 1959

(see IRGR)

368. Schaafsma, N.D.R.- Disposal of solid waste in the Netherlands. Manuscript, 8pp, rec'd. Nov. 1958.

The Netherlands may be divided into two areas: the 'Ranstad' or metropolitan area which is horseshoe-shaped around the Hague (4.0 million, density: 2,422/sq km), and the remainder, southern and eastern Holland (7.0 million, density: 227/sq km). There is no refuse dumping area in the Ranstad and not much market for compost, except in the vegetable-growing area south of the Hague and the bulb-growing area between Haarlem and Leyden. Most towns in this area will have to incinerate refuse as do Sneek, Amsterdam, and Dordrecht, and as Rotterdam plans. Although over 1 million T/yr of compost are needed for agriculture, transportation costs would be excessive and local over-supplies would occur. Between 250,000 and 300,000 T/yr of compost are now being produced, about 127,000 at the Wijster plant alone. Although the Hague now ships refuse by special train the 200 km to Wijster for composting by VAM, the contract expires in 1962 and the City has made a study of costs on the basis of 135,000 T/yr of refuse.

The Hague now pays transportation costs and maintains the transfer station and a small incinerator and these costs are expected to increase to about $2.72/T of refuse. A salvage-incineration plant is estimated to cost $1.95/T net, allowing for power output and salvage sales of scrap iron and ashes. While the author believes these incinerator estimates to be low, based on Swiss and Belgian experience, he shows that costs would be competitive at a haul distance of 100 km to the compost works. The van Maanen system represents the least costly composting method. But on the basis of the City's estimates, the Hague may switch to incineration in 1962.

Net composting cost estimates are given by the author for Dano biostabilizer and rasping system plants serving 44,000 to 120,000 people varying from $1.32 to $2.75/T of waste, including compost selling prices of $1.50-$2.20/T and excluding costs of refuse collection and haul.

Following are the compost works in the Netherlands with populations shown in parentheses:

Composting Plants in the Netherlands

van Maanen - VAM		Rasping System	Dano Method
Wijster from:	Mierlo from:	Delft (70)	Enschede (120)
the Hague (400)	the Hague (250)	Schiedam (80)	Venlo (55)
Zandvoort (15)	Eindhoven (160)	Vlissingen (30)	Soest (25)-
Groningen (145)	Geldrop (18)	Sneek (20)	Baarn (20)
Amersfoort (70)	Best (10)	Hengelo (60)	
Beilen (20)	Nunen (6)	Almelo (50)	

(Ed. note: The new Dantumadeel plant is not shown above)

368. Because of fly, rodent, and odor problems, the van Maanen plants must be remotely sited. Also, refuse trains returning to the Hague bring back flies from the compost works. This does not occur in the rasping system and Dano plants with immediate mechanical treatment of the refuse. The author concludes with a discussion of the VAM and the Compost Foundation.

369. Schulze, K. L.- Rate of oxygen consumption and respiratory quotients during the aerobic decomposition of a synthetic garbage. Proc. 13th Ind. Waste Conf., Purdue Univ., 541-54, May 1958 (Publ. 1959).

Studies were made in a 0.75 cu ft horizontal rotating drum to which air was supplied in the composting of a synthetic garbage. The "garbage", totalling 23.5 lb, comprised: bread-3 lb; potatoes-5 lb; apples-5 lb; ground beef-1 lb; oranges-4 lb; vegetables (carrots, lettuce, celery)-5 lb; coffee grounds-0.5 lb; and newspaper-3 lb. CO_2 and O_2 analyzers were used to check the outlet air and inlet air was regulated such that outlet air contained at lease 2-5% O_2. The respiratory quotient (RQ = CO_2/O_2 by volume) was computed as: % CO_2 in exhaust gas/21-% O_2 in exhaust gas. The raw mixture was ground through a 3/8-in. mesh screen and had 68-71% moisture content. Mixture was air dried to 50-60% moisture before being composted without seeding material. Analyses and weights were obtained initially and finally, except carbon was computed by the New Zealand formula: %C = (100-% ash)/1.8. Moisture increased by an average of 12.5%, N increased from 1.9 to 2.7% (DW); volatile matter decreased from 94.2 to 90.8%; C/N decreased from 28.6 to 19.9, and pH increased from 5.2 to 8.8 during the 14-day (avg) runs. Weight losses were: dry weight-37.6%; volatile solids-40.1%; and total N-10.2%. Oxygen uptake rates were converted to mg O_2 consumed per g of initial volatile matter per hr. Temperature vs logarithm of oxygen uptake rate for the first 7 days of the runs plotted as a straight line. Thus, up to 145°F (63°C), oxygen uptake rates are considerably higher in the thermophilic than in the mesophilic range and greater decomposition occurs. Rates varied from about 1 to 5 mg. O_2/g V.M./hr at temperatures of 90 to 145°F. Thus, to maintain aerobic conditions 9-10 cu ft of O_2/lb/day initial volatile matter or 18,000-20,000 cu ft/ton/day must be supplied during peak demand. Respiratory quotients for the over-all process varied from 0.8 to 0.9. These values agree with those found by Wiley.

370. Scovel, Ralph E.- The Dano method of refuse disposal. Calif. Vector Views (State Dept. of Pub. Hlth.) 5 (2) 5-9, Feb. 1958.

The Dano method of composting is hygienic, economical, and conserving of resources. Dano of America, Inc. represents the Dano Engg. and Mfg. Co., Copenhagen, in the U.S. A full-scale refuse composting plant near Sacramento, Calif. has been continuously operated since Oct. 1, 1956, handling up to 50 T/day. Plant contains: receiving apron conveyor, sorting conveyor, electromagnet, elevating conveyor, biostabilizer (10-1/2 ft diam. x 76 ft long, rotating at 0.8 and 0.2 rpm, with

370. blower, and air and water valves along the length), and vibrating screen. Retention for 10 days in the biostabilizer is claimed to result in a compost with a low C/N value, for one day destroys pathogens by temperatures up to 140°F. No inoculum is used.

The biostabilizer provides aerobic composting with mixing, aeration, and grinding actions. Shorter retention periods are more economical and permit completion of composting in stockpiles, windrows, or after direct application to fallow fields. Present retention in the biostabilizer is a little over 24 hr and the green compost is spread on low quality soil with manure spreaders. The compost contains nutrients (N - 1.25%, P_2O_5 - 0.4%, and K_2O - 0.3%), minor or trace elements, "millions" of microorganisms of benefit to soil, and well over 100% water-holding capacity.

On Jan. 6, 1958 a 15-yr contract was awarded by Sacramento County to the North American Waste Disposal Service Co. for collection and disposal of refuse from the area north of the American River. The latter company contracted with Dano and plans are to enlarge the present plant to 100 T/day. Dano does not plan to merchandise the compost but "does want to recondition land with its end product and is able to dispose of the compost for any community producing it by this method".

371. Script, Ann- In Bristol fashion. Pub. Cleansing 50 (2) 77-8, Feb. 1960.

A reporter gives the highlights of the Cleansing and Transport Officer's report in Bristol covering three years. There are 88 refuse and salvage collection vehicles and 8 "gulley-emptiers" in use. Refuse, waste paper, and kitchen waste are collected separately at 'kerbside'.

During the year ended Mar. 31, 1959, 12,074 tons of waste paper were salvaged for an income of $140,000 and a profit of $56,000. Kitchen waste, also salvaged, amounted to 12,782 tons for which a loss of $4,000 was incurred. The declining tonnage of garbage 'is undoubtedly attributable to the increasing quantities of frozen and pre-packaged foods now being sold almost universally'. Disposal of wastes is largely by sanitary landfill.

372. Shuval, Hillel- Composting municipal garbage in Israel. Tavruah (Assn. of Sanitarians in Israel) (5) Reprint, pp 26-39, July-Dec. 1958.

Israel's 20 major cities (1.2 million) produce 880,000 cu m of garbage (refuse)/yr, or 2.2 lb/cap./day, largely disposed of in open dumps. Average refuse density is 400-600 kg/cu m of which 84% is compostable. Agricultural authorities estimate a need for 1 million cu m/yr of additional organic materials of which only 25% could be supplied by refuse compost. Farmers pay $2.80-5.00/cu m for compost and a favorable market has stimulated compost development.

372. Experimental windrow composting was conducted at Jerusalem, Nathanya, Rehovoth, Hof Hacarmel, Naaman, and Beersheba by a method similar to the van Maanen process. The windrows of unsorted refuse were usually anaerobic, conducive to fly breeding, and caused a nuisance. Also turning and hand sorting labor costs were high and all but the last two cities discontinued this method.

At Tel Aviv 4 reclamation plants processing 1,000 cu m of compost/day are working over old dump sites, screening the rotted refuse for compost and salvaging from the tailings. Similar plants are going in at Jerusalem, Ramleh, and Haifa. These typically have a tractor shovel, rotary screen (25 mm holes, 13 rpm), and transporting and sorting conveyors. The concessionaire makes a reasonable profit selling compost at $2.78-3.90/cu m while still paying the city $0.90/cu m of finished compost for the right to work. The presence of broken glass and soil in the compost reduces its quality for horticulture but a ready market is found for use in citrus groves. Tel Aviv is trying a modified landfill using a 20-cm cover of stabilized refuse with the hope of later reclaiming compost similarly.

Domen, Ltd. operated a pilot mechanical compost plant (80-100 cu m/day) starting in 1957, also at Tel Aviv. Steps are: receiving, sorting, magnetic separation, grinding in a rasping machine, ballistic separation, and windrow composting for 3-4 weeks with turnings at 3-day intervals. A temperature of 60-70°C (140-158°F) is reached in 3 days. Turning is by tractor shovel. A 500 T/day plant will be supplied by Dorr-Oliver and privately financed for $1.1 million, or about $2,500/T of rated capacity. The City will pay $0.14/cu m for disposal. The plant should be completed in 1960.

Haifa (150,000) recently contracted for a Dano biostabilizer plant of 50 T/day (1/3 the refuse). This involves separation, composting in a slowly rotating drum, final screening and separation. Capital cost (private) will be $250,000, or $5,000/T of rated capacity.

The high organic content of Israel refuse and the shortage of organic matter are believed to be the reason composting is attractive. Also scrap metal brings $16.70/T and rags $27.80/T so that each ton of refuse should be worth $1.00 from these items alone.

373. Shuval, H.- Israel is tackling her composting with a will. Munic. Engg. (Br.) 136: 241 and 243, 1959; W.P. Abs. 32 (9) 1686, Sept. 1959.

"The author discusses methods for the preparation of composts from garbage in Israel, including non-mechanical open windrow composting, now only carried out at Naaman and Beersheba; mechanical stabilization of garbage from open dumps, as at Tel Aviv; anaerobic decomposition of

373. garbage in open dumps after stabilized garbage is added daily to reduce fly breeding; and the new completely mechanical composting plants planned for Haifa and Tel Aviv, which will treat 50 and 500 tons of garbage per day, respectively. A comparison is given of the advantages and disadvantages of each method and the costs of the preparation of composts in a country where they are badly needed for agriculture, and where the garbage has a high percentage (about 84 percent by weight) of compostable material, are reviewed." (WP)

374. Spohr, Guerter and Eckenfelder, W. Wesley, Jr.- Sewage sludge thickening by mechanical vibration. Pub. Wks. 89 (3) 111-2, Mar. 1958.

The Heymann process, developed in Germany in 1954, utilizes a vibrating screen and rotary filter press to dewater sludge. There are more than 20 installations in Germany and Switzerland. It has recently been patented in the U.S. and tested at Green Bay, Wisconsin and W. Paterson, New Jersey with successful results. The vibrating screen, equipped with combs at intervals, operates at 1200 rpm involving a double amplitude of 7.8 to 8.4 mm. Sludge then passes to a roller press which may also be vibrated.

Tests on the W. Paterson Imhoff tank sludge at feed rates of 600 to 1000 gph gave concentrations of from 8 to 10% dry solids to 28.6 to 35.0% solids from the press. Tests at W. Paterson on raw Lake Hiawatha sludge and on digested Little Falls sludge increased solids content from 4-5% to 26-28.5%. Swiss studies showed increased solids from 11.1 to 19.4% by the screen and a further increase to 24.2% from the press. Filtrate solids contents are quite high (40-90% of that in initial sludge). Reduction in sludge odors and ease in final air drying are claimed. (Equipment is sold by Sonic Separation, Inc., P.O. Box 37, Lake Hiawatha, N.J.) (See abs. 327)

375. Stahlschmidt, Victor- Worldwide distribution of Dano biostabilizer composting plants. Pers. commun., transmitted Jan. 18, 1960.

Distribution of Dano biostabilizer refuse composting plants is shown below by continent, country, and city. Capacity in long tons and plants treating sewage sludge in addition are shown parenthetically.

EUROPE

Denmark	Scotland	The Netherlands
Søllerød (25)	Edinburgh I (20)	Enschede (40-60+s)
Rødovre (10)	Edinburgh II	Soest-Baarn (30)
Gladsaxe (50+s)	(140-2 units)	Maastricht (100+s)
	Edinburgh III (70)	Venlo (40)

Germany
Duisburg (100+s) (2 units)
Bad Kreuznach (30)

Italy
Mantova (Mantua) (30)*
Udine (20-30)

Sweden
Trollhättan (15-25)*

Switzerland
Rüschlikon (5-6)
Chur (Coire) (15-20)

England
Redditch (40)*
Dunbarton (20)*

Iceland
Reykjavik (70-2 units)

Norway
Bergen (100-2 units)

Finland
Turku (Abo) (50)*
Helsinki (Helsingfors) (25-50)

France
Pontarlier (15)

Belgium
Brussels (Bruxelles) (100)*

ASIA

Saudi Arabia
Dhahran (6)
Riyadh (15)*

Japan
Himeji (25)
Onomichi# (20)*

Israel
Haifa (50)

SOUTH AMERICA

Brazil
Mogi das Cruzes (30)*

Ecuador
Quito (20)

NORTH AMERICA

United States
Sacramento County, California (20)

* Under construction. # May be Onimichi or Unomachi.

376. Steffes, Milton J.- Williamston, Mich. conducts successful composting operation. Amer. City 73 (8) 94-5, Aug. 1958.

Williamston (2,500) has owned and operated a Riker composting system, engineered by Johnson and Anderson, Inc., Pontiac, Mich., for two of the last 3 1/2 yr. Raw sewage sludge, garbage, and corn cobs are mixed in the 5 T/day plant and composted in mechanical units in 21 days. Raw sludge is concentrated on a Komline-Sanderson Coilfilter to a cake of about 65% moisture. This cake is added to garbage, bacterial culture, and corn cobs and the mixture ground in a hammermill. It is then conveyed by Hapman tubular conveyor to the top chambers of the two digesters, each containing 4 bins. Clamshell bottoms of the bins are opened every 5 days to drop the compost into the bin beneath. Forced air is provided. After 21 days in the 4 bins, the compost is conveyed by the same tubular conveyor to a storage bin where it is reground and ready for sale. Composting costs are reported as $3.40-3.75/raw ton or $7.00/T of compost. Selling price to greenhouses and homeowners is $40/T. Builders estimate the cost of duplicating this plant for a city of 5,000 would be about $150,000 ($30/cap.).

377. Stirrup, F. L.- Production of briquetted fuel and of fertilisers from refuse. Pub. Cleansing 49(585) 275-89 and discussion 289-92, May 1959.

The author proposes the sorting and grinding of refuse, with salvage, followed by composting the fines and briquetting the course particles. He found that experiments were being conducted in Germany and Switzerland and the equipment items had been developed in Switzerland. He made some tests of briquetting at Salford, England, where he is Dir. of Public Cleansing, although he had to call on nearby Manchester for the separation. The composting process recommended is the Earp-Thomas process but this was not tested in England. There is an experimental composting and briquetting plant at Muttenz, adjoining Basel on the Swiss-German border. Suffice it to say about the composting, the author claims it is better accomplished with the finely-ground material and that it is sufficiently stabilized in 24 hours (Ed. ?).

British refuse analysis indicates 47.3% fine dust (below 5/16-in. mesh); 12.9% cinders (5/16-3/4-in.); 6.5% cinders over 3/4-in. mesh; and only 5.1% vegetable and putrescible matter. The rest is composed of paper, metals, textiles, glass, bones, and about 10.6% classed only as combustible and non-combustible debris. The calorific value of refuse briquettes after more or less sorting varies from 4,232 to 7,567 Btu/lb. This value is based on the following analysis:- Moisture: 3.6-7.2%; ash content: 15.6-51.4%; fixed carbons: 12.2-29.3%; and volatile matter: 32.8-60.7%.

Grinding is accomplished in a Novorotor grinder, having two parallel-axis hammermills with screens below and a blower system to convey the ground product. The hammers recommended are 20 mm thick and of special steel. Although 20 mm perforated screens were used, better results are obtained with refuse using sets of "knife bars". The hammermill is claimed to be more satisfactory and less costly in maintenance than two hammermills in series. The capacity varied from 5 to 10 T/hr.

The British refuse contained 30% moisture and required drying before briquetting, the moisture content being critical since no binding agent is used. The Glomera suspension dryer is recommended, the ground refuse being suspended in a vertical rise pipe by hot moving air until it is dry enough to be blown up and be discharged through an outer "down" pipe. The refuse is fed through a horizontal pipe by means of a blower into the bottom of the dryer. Optimum air temperature in the dryer was around 200-250°C. The correct temperature must be used depending on the moisture content of the feed. Capacity achieved was 3-4 T/hr. An oil burner is normally used but the air may be pre-heated by flue gases from a trade refuse incinerator, if available.

The briquetting machine is a Glomera briquettor, model 412, driven by an 80 kw motor. Two flywheels are mounted on crankshafts fitted with connecting rods which drive a heavy crosshead back and forth with each

377. revolution. There is a piston mounted on each crosshead and with each stroke they transfer a quantity of material from inlet chamber to the pressure head. With each stroke a briquette is formed and they are pushed forward into the after-pressure nozzle for discharge from the press. The briquettes are 2-1/2-3 in. in diam. and can be of any desired length. A floor plan, elevation, and cost data for a plant are given for an operation producing 60 tons of briquettes in two eight-hour shifts. Operating and amortizing costs amount to $3.20 per ton. Savings of $75,600 or $0.90 per ton are claimed for Salford.

There was much discussion, mainly about whether or not the proposed scheme is practical, will interfere with other fuel sales (there is a coal surplus in Britain), and approval for loans may be obtained from the Ministry of Housing and Local Government. The reaction of the discussors was generally not favorable.

378. Tatsuno, Tsuneo- Humification of rice straw compost by 'Sokusei-taihi' method. Bull. Univ. Osaka Prefect., Ser. B 7, 57-63, 1957; Chem. Abs. 53 (2) 1608f, Jan. 25, 1959.

Composting of straw in piles, first with addition of a calcium fertilizer and second with a nitrogen fertilizer, for a total of 45 days is termed the 'Sokusei-taihi' method. Analyses by Waksman's method showed that, in the short first stage, alcohol-benzene extract and hemicellulose contents decreased rapidly, total and organic solids decreased slowly, and the N:lignin ratio and cellulose content were unchanged. In the longer second phase, total and organic solids and cellulose content decreased rapidly, hemicellulose decrease slowed down, the N:lignin ratio was narrowed. A well-rotted compost was obtained.

379. Tietjen, Cord and Banse, Hans Joachim- Soil improvement society organized to produce and utilize compost of refuse. Calif. Vector Views (State Dept. of Pub. Hlth.) 7 (1) 1-5 and 7, Jan. 1960.

The authors classify composting processes according to the viewpoint of the compost consumer:

Location	Large Non-compostables Removed	Aeration	Sewage Sludge Added	Mixing and Turning
Wijster, Holland; Baden-Baden, Germany	After composting	Uncontrolled	Periodically	None
Delft, Holl; Heidelberg, Ger; McKeesport, Pa; Chandler, Ariz.	Before composting	Uncontrolled	Not usually	By grinding
Mierlo, Holland; Oakland, Calif.	Before composting	Uncontrolled	Not usually	During windrowing
Bad Kreuznach, Ger; Soest-Baarn, Holl; Sacramento (Co), Calif; Norman, Okla; Williamston, Mich.	Before composting	Controlled	Periodically	Continuous in 1st phase, sometimes periodically afterwards

379. An example of close cooperation between refuse producer and compost consumer is Bad Kreuznach where a cooperative for soil improvement was founded consisting of vineyard owners and three political boards. This cooperative, receiving federal and township aid, constructed and is operating a Dano-type composting plant. The plant treats 25 T/day in a biostabilizer 11-1/2 ft in diam. x 80 ft long for 5-7 days. Depending on the time of year, screened compost is applied to vineyards (on slopes up to 40° with rows running up and down hill) either "green" or after curing in windrows. A blower is used to distribute the compost downhill in the vineyards. Processing and administrative costs of compost production are shared by members of the cooperative.

380. van de Plassche, A. W.- Development and significance of compost preparation in the Netherlands. Int. Cong. on Disp. & Util. of Town Refuse, 4pp, Apr. 1959; IRGR (7) 2-3, December 1959.

(see IRGR)

381. Vincenz, Jean J.- Is baled refuse the answer? Amer. City 75 (2) 149 and 151-2, Feb. 1960; and -- For easier refuse handling and disposal ... will baling be the answer? Pub. Wks. 91 (2) 113-4, Feb. 1960.

The author suggests the following three phases of refuse treatment with ultimate disposal by the sanitary landfill method:

"A. Install a baler at the refuse transfer station that will really compress and bale, possibly with baling wire or metal straps, a quantity of refuse somewhere between the size of a bale of hay and a bale of cotton.

"B. Use a low-boy or some other trucking conveyance that can haul a large pay-load to the disposal site.

"C. Stack the bales side by side and on top of each other in the ordinary method of stacking baled hay, using earth cover to maintain a sanitary fill."

Advantages are given as: "greatly reduced hauling costs, longer term of use for the disposal site, less blowing of paper at the site and a much neater appearance".

382. White, W. F.- Centrifugal treatment of sewage and industrial waste. Mimeo. (Pres. at Ohio Sew. & Ind. Waste Tr. Conf., June 17, 1959) 13pp.

The Bird solid bowl continuous centrifugal separator, in use for years in process industry, has recently come into use for sewage sludge dewatering. The Los Angeles County Sanitation Districts' Joint Disposal Plant has a 40-in. x 60-in. centrifuge driven by a 100 hp motor. Within a rotating bowl (1600 rpm) is a rotating, screw conveyor (1580 rpm)

382. such that there is a differential speed of 20 rpm. The author cites installations serving various industries and then discusses sewage sludge centrifugation.

Digested sludge from a primary plant, the North San Mateo County Sanitation Treatment Plant at Daly City, California, is fed to an 18-in. x 28-in. Bird centrifuge at 30 gpm. Sludge solids are increased from 5 to 35%, and 50% of the solids are recovered in the cake. This was an industrial machine; sludge machines are claimed to give better results.

About the first of 1957, San Leandro, California, installed a 40-in. x 60-in. centrifuge, used for both digested and raw sludges. It produced a 30% solids cake at a 300 gpm feed rate. The Los Angeles County installation came after testing L.A. sludge in the San Leandro centrifuge. L.A. County District Engineers estimate that costs will be $3/ton to dewater sludge at a 150 gpm feed rate, including amortization and trucking to drying beds. This compares with costs of $12-13/ton for elutriation, chemical treatment, and vacuum filtration of sludge according to the author. Concord, California, recently bought a 24-in. x 38-in. centrifuge for 35 gpm of digested sludge, costing less than the capital expense for drying bed enlargement. (see abs. 347)

383. Wiersum, L. K.- Humus and root activity. Int. Cong. on Disp. & Util. of Town Refuse. Mimeo. 9pp, Apr. 1959; IRGR (7) 14-16, December 1959.

(see IRGR)

384. Wilkinson, J. and Frake, G. A.- Refuse disposal at Worthing. Roy. Soc. of Health Journ. 75 (10) 745-54, Oct. 1955.

A new plant has been completed at Worthing (70,000) using separation and controlled tipping. Separation reduces the required land area for the sanitary landfill and brings revenue from salvage. Composting or pulverization were discarded because of 'sales resistance'. Refuse data are: maximum 85 T/day (8 hr); average 18,000 T/yr; average pre-separated salvage 1,100 T/yr. Cost of the works was $160,300. The refuse trucks tow salvage trailers and some separation is gained at collection time.

The separation plant includes an 80-cu yd hopper with moving floor; elevating conveyor; rotary screen to separate first dust, second cinders; magnetic separation; picking belt for mixed paper, newspaper, cardboard, books and magazines, non-Fe metals, Fe metals, rags, bones, cullet, whole bottles and jars; salvage balers. Tailings from the screen are tipped and covered with the dust (estimated at 29% of total salvaged weight of 18,000 T/yr). Weights of other salvaged materials are: cinders 19% (no use given), vegetable and putrescible 4.7% ($11.20/T), paper 12% ($23/T), tins 3.5% ($13.44/T), Fe metals 1.5% ($9.80/T), rags 0.5% ($56/T), bottles and jars 5% ($7/T), cullet 1% ($4.20/T), bones and fat 0.3% ($18.20/T), and debris 22.5%. Collection cost is about $6.02/T of refuse or $1,596/1,000 pop./yr. (Ed. note: Weights are in long tons).

385. Wilson, N. G.- A British survey of foreign refuse practice. Refuse Removal Jour. 2 (3) 15-17, 27-29 and 32, Mar. 1959.

Nearly the first 6 pages of this article deal with collection methods, anti-litter programs, etc. and will not be presented here. Disposal methods in England and Wales at 453 local authorities in 1956, as reported by the Ministry of Health, were: 323 (pop. 17 million) sanitary landfill; 35 (pop. 2-1/3 million) separation-incineration; 92 (pop. 12 million) both sanitary landfill and separation-incineration. A survey by APWA in the U.S. also in 1956 revealed, of 851 cities reporting: 482 - sanitary landfills; 124 - incineration; 5 - dumping in water; 2 - central grinding; and 1 - composting. Household garbage grinders are gaining favor in the U.S. and Canada but New York prohibits them because of overloaded sewers.

The USPHS has evaluated the quality of sanitary landfills, rating 1,000 of them as A, B, C, and U. The "C" rating means operating techniques permit nuisance or health hazard development, while "A" and "B" are roughly Good and Acceptable, respectively. "U" means unknown. Results of the rating survey: A - 37%, B - 29%, C - 17%, and U - 17%.

New York City is in the midst of a $70 million incinerator program, building 11 new incinerators and rehabilitating 5 others. Slightly under half of the 3-1/3 million T/yr of collected refuse is disposed of in landfills. Most Swedish refuse is disposed of by controlled tipping, only 5% of all cities using incinerators. There are 3 Dano composting plants in Sweden. In Finland 2 composting plants "are shortly being erected", one at Helsinki plus an incinerator. Most refuse is dumped after reduction in special home incinerators. Brussels hauls refuse to dumps in trains, as does the Hague to compost plants. Composting is practiced in West Germany at Baden-Baden and Heidelberg. East Berlin has 5 composting centers. Czechoslovakia prohibits incineration of refuse by law unless during an epidemic.

386. Wilson, N. G.- Some views of a Briton on sanitation in the U.S. Refuse Removal Jour. 2 (11) 22-3, Nov. 1959.

Although there is enthusiasm for incineration and much thought given to design, there is no standard incinerator design and there is great variation in the features. The 500-T Washington D.C. incinerator (1955) cost $2 million and provides expansion chamber and flue volume of 209 cu ft/ton, greater than any other known plant. That city collects refuse containing only 3% garbage because the garbage goes to hog feeders. Density of refuse is only 2.5 cwt/cu yd. The Abbington, Pa. 200-T incinerator (1955) has a safety device incorporating a fire jet system to throw a curtain of water over any refuse burning in the storage hoppers. The furnace is of the mechanized inclined type with recording pyrometers controlling overhead fans to prevent overheating (1,800°F) of the furnaces. Garden refuse is handled in some U.S. cities by mobile brush chippers.

386. Composting in Europe is discussed. Budapest and 32 other Hungarian cities produced a total of 200,000 T of compost in 1955. A plant is under construction at Bangkok for $1,999,200 to compost 1,400 cu yd/day of refuse. In the United Kingdom many separation-incineration plants have been built in the last 10 years because of lack of sites for controlled tipping. The air pollution problem and the value of organic wastes for the soil, however, may cause a swing to separation-composting installations. Edinburgh is changing from incineration to composting with a new 140-T plant.

New York City is introducing an electronic weighing system with 30 weigh stations costing $1/2 million. Snow removal in the U.S. starts with salting on a snow warning and follows by mechanical removal by various means for the deeper snow. Heating elements are used in some places, although costly, under walks and roadways for snow and ice control.

Although refuse density continues to decline, there seems to be more interest in Europe in mechanical loading than in the U.S. The trend in refuse collection vehicles is towards an even higher ratio of compaction.

387. Wylie, J. C.- Refuse disposal trends and composting methods. The Surveyor 117 (3440) 277-80, Mar. 29, 1958.

This paper, "Future trends in refuse disposal -- analysis of composting methods", was given before the Inst. of Munic. Engrs. Past and present refuse disposal methods are briefly discussed. Salvage should not be neglected for economic reasons and the author quotes present prices per long ton as: baled tins - $22.40; paper - $8.40 to $28.00 ($44.80 in 1951); uncleaned rags - $16.80; bones - $22.40; broken glass - $2.80; and cinders - $1.40 to $2.10. By weight, British refuse contains 30-55% fine dust, 20-30% cinders, 1-12% vegetable content, 10% unclassified, and the remainder is paper, metal, rags, bones, and cullet.

A normal British disposal practice is the operation of a segregation plant where refuse is screened, separated magnetically, and sorted of salvage and discard items. The remainder consists of fine dust, soiled paper and rags, the garbage content, and some debris. He indicates it is wasteful and causes air pollution to burn this material.

Composting of the "tailings" decomposes them to produce a humus-forming material with C/N value of 10-20. Various composting methods are described. Composting is effected by microorganisms and is an oxidizing process producing CO_2 and H_2O from the carbohydrates. Some NH_3 may be lost. Composting is a sterilizing process due to antibiotic production and development of high temperatures. "No pathogenic organism is likely to survive when subjected to temperatures of around

387. 160°F for a few minutes or 120°F for several days. Temperatures within that range and over these periods of time are characteristic of all established mechanised composting systems."

Tailings and fine dust (mostly ashes and floor sweepings) contain barely more than 0.5% N and form the basic composting materials. Sewage sludge is rich in N and complements the refuse, being thoroughly mixed with it. Refuse is reduced in hammermills, rasping machines, or the Dano biostabilizer or egsetor. These are described. Refuse has about 20% moisture and the composting mixture must have 40-60% moisture, the sewage sludge providing the needed water. In the Dumfriesshire system waste straw and ground refuse serve as a filter for sewage sludge for dewatering the sewage solids. Elsewhere sludge is applied either after digestion and partial drying, or wet up to the limiting moisture content desired.

Composting may be accomplished in batches in windrows or pits, in multistage vertical silos (as the Jersey, Frazer-Eweson, and Earp-Thomas systems), or in a continuous process (as the Dano biostabilizer). The latter provides continual mixing, grinding, and aeration in a long horizontal, slowly-rotating drum. Treatment is for 2-1/2-5 days but the compost must subsequently be cured for 3-4 weeks, generally. "The emergence of mechanised composting systems of proved efficiency provide health authorities with a new disposal method which under many circumstances will prove to be cheaper than other established methods." Compost has a value only slightly lower than that of farmyard manure and is finding a ready market in Britain at prices around $5.00/short ton.

388. Xanten, William A.- Reclamation and salvage operations. APWA Yearbook, 92-99, Nov. 1959 (see also: Refuse Removal Jour. 2 (12) 17, 18, 20-22, 26, Dec. 1959).

Cities are reluctant to consider salvage because of fluctuating markets, unless an alternative method of disposal exists. There have been many pitfalls and sad experiences resulting from precipitate action without proper engineering and cost analyses based on local conditions. Market prices of salvage items have not kept pace with the spiraling labor costs and therefore city officials must take a dim view of "all-out" salvage as a sound approach to refuse disposal.

Regarding rubbish, typical items may be classified as they relate to resale value:

Resale Value		No Resale Value	
Rags	Bottles	Leather	Sawdust
Newspaper	Rubber	Enamel ware	Straw
Mixed paper	Ferrous metal	Excelsior	Dirt
Cardboard	Non-Fe metal	Mattresses	Miscellaneous
Books & magazines	Broken glass	Matting	Synthetic fabrics
		Linoleum	Plastics

388. Garbage may have some value for its organic material, and bones, ashes, and cinders may be of some value. Rags represent one of the most stable items of value in refuse but, as of 1956, the amount had dropped in the refuse to about 1%. Paper and its products have continued an upward trend in amount and represent the larger proportion of salvable materials in refuse. But its value fluctuates more than any other and at times the market is non-existent. It has varied from 3¢ to $1.55/cwt for wastepaper. Price of cullet has not kept pace with rising labor costs. The Los Angeles By-Products Co. reported in 1959 that unwashed cullet, delivered to the processor, sold for $9/T for flint cullet and $8/T for amber cullet. Bottle salvage was limited to returnable soft drink and other deposit bottles, being sold on a tonnage basis to a firm engaged in bottle salvage and washing at $22-30/net ton.

Tin cans and metal scrap can be salvaged before or after incineration. Market varies geographically. Unburned cans can be shipped to detinneries with resultant recovery of both tin and ferrous metals. Tin interferes with the open hearth steel mill operation. There is a very limited market for low-priced baled tin cans for sash weight or other crude metal production. A somewhat broader market exists for use of tin cans in copper precipitation in the Southwest without the necessity of baling.

Other items discussed are salvage at the source, waste heat utilization, and research and development. Under the latter, regarding composting, the following is stated: "Suffice it to say that what the future holds for this method will largely depend on the existence of realistic and sound market outlets for the by-product. In the final analysis no system of refuse disposal can long endure unless it rids a community of its solid wastes in as economical, healthful and positive manner as possible."

389. Zürich Symposium-1955- Present problems in refuse disposal, treatment, and utilization. R. Oldenbourg (Publ.), München, 174pp, 1957; Schweiz. Zeitschrift für Hydrologie 17 (2) -- 1955; IRGR (6) 11, July 1959.

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